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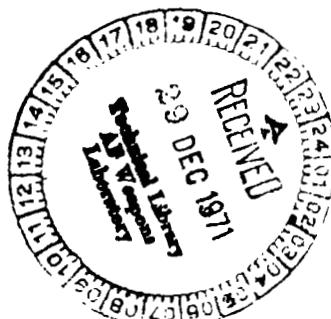
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AN INVENTORY OF  
AERONAUTICAL GROUND  
RESEARCH FACILITIES

Volume II — Air Breathing Engine Test Facilities

by C. J. Pirrello, R. D. Hardin, M. V. Heckart,  
and K. R. Brown

Prepared by  
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Moffett Field, Calif.



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16. Abstract This volume of the Aeronautical Ground Research Facilities Inventory covers free jet and direct connect altitude cells, sea level static thrust stands, sea level test cells with ram air, and propulsion wind tunnels. Free jet altitude cells and propulsion wind tunnels are used for evaluation of complete inlet-engine-exhaust nozzle propulsion systems under simulated flight conditions. These facilities are similar in principal of operation and differ primarily in test section concept. The propulsion wind tunnel provides a closed test section and restrains the flow around the test specimen while the free jet is allowed to expand freely. A chamber of large diameter about the free jet is provided in which desired operating pressure levels may be maintained. Sea level test cells with ram air provide controlled, conditioned air directly to the engine face for performance evaluation at low altitude flight conditions. Direct connect altitude cells provide a means of performance evaluation at simulated conditions of Mach number and altitude with air supplied to the flight altitude conditions. Sea level static thrust stands simply provide an instrumented engine mounting for measuring thrust at zero airspeed. While all of these facilities are used for integrated engine testing, a few provide engine component test capability. Engine component testing is essential to development but complete coverage of component test facilities is considered beyond the scope of this report. Otherwise, this listing of major airbreathing jet engine test facilities is considered to be relatively complete.			
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## PREFACE

McDonnell Aircraft Company has conducted an inventory of Aeronautical Ground Research Facilities under contract number NAS 2-5458 (Modification 1) for NASA's Advanced Concepts and Missions Division, Office of Advanced Research and Technology (OART) located at Ames Research Center, Moffett Field, California. The inventory is intended to provide sufficient documented facility information to be used by government and industry engineers and scientific personnel for planning test programs relative to advanced aeronautical systems. The inventory is arranged by major facility category in four volumes for convenience.

Volume I - Wind Tunnels  
Volume II - Airbreathing Engine Test Facilities  
Volume III - Structural and Environmental Facilities  
Volume IV - Engineering Flight Simulation Facilities

The primary content of each volume is a compilation of facility data pages which provide information descriptive of the general arrangement, performance, testing capability, and where available, acquisition and operating costs of each facility inventoried. Also, sufficient additional source references are provided for those requiring more detailed information. Summary tables in each volume list facilities by type and alphabetically by reporting installation along with brief data descriptive of the facility. An index of facilities is provided which is arranged alphabetically by reporting installation and functional name of each facility under that installation's cognizance.

This inventory was accomplished in five (5) basic steps which included: (1) a literature search to identify candidate facilities, (2) formulation and distribution of appropriate questionnaire to facility operators, (3) preparation of preliminary facility data pages (based on completed questionnaires), (4) operator review of facility data pages to insure accuracy, and (5) final draft of the report.

The facilities included in this inventory do not necessarily represent the total ground research capability of each reporting installation, but rather its major capabilities. Those facilities included were chosen on the basis of several factors such as size, operating range, and uniqueness.

VOLUME II - ABSTRACT  
AIRBREATHING ENGINE TEST FACILITIES

This volume of the Aeronautical Ground Research Facilities Inventory covers free jet and direct connect altitude cells, sea level static thrust stands, sea level test cells with ram air, and propulsion wind tunnels. Free jet altitude cells and propulsion wind tunnels are used for evaluation of complete inlet-engine-exhaust nozzle propulsion systems under simulated flight conditions. These facilities are similar in principal of operation and differ primarily in test section concept. The propulsion wind tunnel provides a closed test section and restrains the flow around the test specimen while the free jet is allowed to expand freely. A chamber of large diameter about the free jet is provided in which desired operating pressure levels may be maintained. Sea level test cells with ram air provide controlled, conditioned air directly to the engine face for performance evaluation at low altitude flight conditions. Direct connect altitude cells provide a means of performance evaluation at simulated conditions of Mach number and altitude with air supplied to the flight altitude conditions. Sea level static thrust stands simply provide an instrumented engine mounting for measuring thrust at zero airspeed. While all of these facilities are used for integrated engine testing, a few provide engine component test capability. Engine component testing is essential to development but complete coverage of component test facilities is considered beyond the scope of this report. Otherwise, this listing of major airbreathing jet engine test facilities is considered to be relatively complete.



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## REPORTING INSTALLATION INDEX

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B. SUMMARY TABLES

B.1. ALTITUDE TEST CELLS (Government Owned)

Organization Location Facility Name GOVERNMENT OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Thrust Measuring Capacity (lbf)	Total Temp. (°R)	Mass Flow Rate (lb/sec)	Page
AEDC Arnold Air Force Station, Tennessee Airbreathing Propul- sion Test Unit	Altitude, blowdown (Free jet or direct connect)	Not Available	Not Available	Not Available	Not Available	Not Available	1-2
AEDC Arnold Air Force Station, Tennessee Altitude Test Cell T-2	Altitude (Free jet or direct connect)	Not Available	Not Available	Not Available	Not Available	Not Available	1-2
AEDC Arnold Air Force Station, Tennessee Altitude Test Cell T-4	Altitude (Free jet or direct connect)	Not Available	Not Available	Not Available	Not Available	Not Available	1-2
AEDC Arnold Air Force Station, Tennessee Altitude Test Cell J-1	Altitude (Free jet or direct connect)	Not Available	Not Available	Not Available	Not Available	Not Available	1-2
AEDC Arnold Air Force Station, Tennessee Altitude Test Cell J-2	Altitude (Free jet or direct connect)	Not Available	Not Available	Not Available	Not Available	Not Available	1-2
AEDC Arnold Air Force Station, Tennessee Propulsion Research Test Bed R-2B	Altitude (Free jet or direct connect)	Not Available	Not Available	Not Available	Not Available	Not Available	1-2
AFAPL Wright-Patterson Air Force Base, Ohio Altitude Test Cell No. 1	Altitude (Direct connect)	10 diam. x 17.3L (Test cell)	To 1.5	3000	Ambient to 395	To 32	1-4
AFAPL Wright-Patterson Air Force Base, Ohio Ramjet Combustion and Viscous Mixing Facilities	Altitude (Free jet or direct connect)	Not Available	Not Available	Not Available	380-1660	.3-32	1-6
Air Force-Marquardt Jet Laboratory Van Nuys, California Full Scale Altitude Cell No. 8	Altitude (Free jet or direct connect)	14 diam. x 80L (Bellmouth diameters to 2.67 ft)	.8-8.2	100,000	To 5000	To 800	1-14
Air Force-Marquardt Jet Laboratory Van Nuys, California Small Scale Altitude Cell No. 7	Altitude (Free jet or direct connect)	6 diam. x 30L (Bellmouth diameter is 1 ft)	Not Available	35,000	To 5000	To 200	1-16

B.1. ALTITUDE TEST CELLS (Government Owned) (Continued)

Organization Location Facility Name  GOVERNMENT OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Thrust Measuring Capacity (lb <sub>f</sub> )	Total Temp. (°R)	Mass Flow Rate (lb/sec)	
NASA Lewis Cleveland, Ohio Altitude Test Cell No. 1	Altitude	14 diam. x 24L (Test cell)	Not Available	Not Available	To 1060	To 450	1-18
NASA Lewis Cleveland, Ohio Engine Research Bldg.	Complex of 65 test cells w/altitude capability	57Wx20Hx80L, 10 diam. x 60L, and other test cells	Not Available	Not Available	480-560	To 141	1-20
Naval Air Propulsion Test Center Trenton, New Jersey Engine Altitude Test Cell Facility No. 3E	Altitude	17 diam. x 30L (Test cell)	To 3.0	50,000	395-1660	To 550	1-22
Naval Air Propulsion Test Center Trenton, New Jersey Engine Multipurpose Test Cell Facility No. 3W	Altitude	33Wx33Hx196L	Not Available	Not Available	395-680	To 350	1-24
Naval Missile Center Point Mugu, Calif. Propulsion Test Lab.	Altitude (direct connect)	30Wx15Hx45L (Preflight Test Pad)	1-3.9	5000	Ambient to 1040	4-20	1-26
Ordnance Aerophysics Laboratory Daingerfield, Texas Altitude Test Cell No. 6	Altitude, continuous or blowdown, (Free jet or direct connect)	15 diam. x 71L (4.19 diam. free jet nozzle max. or 4 diam. bellmouth diam. max.)	1-5	60,000	to 3960	50-1600	1-28

B.1. ALTITUDE TEST CELLS (Industry & University Owned)

Organization Location Facility Name  INDUSTRY OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Thrust Measuring Capacity (lb <sub>f</sub> )	Total Temp. (°R)	Mass Flow Rate (lb/sec)	Page
Allison Indianapolis, Indiana Altitude Test Cell No. 1	Altitude (direct connect)	18 diam. x 68L (Test cell)	Not Available	30,000	395 to Ambient	To 450	1-8
General Electric Co. Ervendale, Ohio Altitude Test Cell No. 43	Altitude (direct connect)	17 diam. x 56L (Test cell)	To 3	100,000 (Thrust frame capacity)	410-1110	1000 (ram only) 400 (ram exhaust)	1-12
United Aircraft Corp. E. Hartford, Conn. Altitude Engine Test Stand No. X-210	Altitude (direct connect)	22.5L (Test cell)	To 3	25,000	425-1135	To 584	1-30
United Aircraft Corp. West Palm Beach, Fla. Altitude Test Cell No. C-4	Altitude (direct connect)	6.5 diam. x 20.7L (Test cell)	To 3.2	Not Available	To 1160	To 480	1-32
<hr/>							
UNIVERSITY OWNED							
Applied Physics Lab. Johns Hopkins Univ. Scaggsville, Maryland Propulsion Research Laboratory	6 altitude test cells	(4) 12Wx10Hx40L (1) larger, (1) smaller, (Test cells)	1-10	Not Available	To 9000	To 100	1-10

## B.2. SEA LEVEL STATIC THRUST STANDS (Government Owned)

Organization Location Facility Name  GOVERNMENT OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Thrust Measuring Capacity ( $lb_f$ )	Total Temp. (°R)	Mass Flow Rate (lb/sec)	Page
AFAPL Wright-Patterson Air Force Base, Ohio Sea Level Engine Test Cell No. C	Enclosed, sea level static test cell	45Wx51H (Test cell)	-	20,000	Ambient	-	2-4
AFFTC Edwards, California Horizontal Thrust Stand Facility	Open air, sea level static thrust stand, complete aircraft	-	-	125,000	Ambient	-	2-6
Naval Air Test Center Patuxent River, Maryland Sea Level Engine Thrust Stand	Open air, sea level static floating thrust stand, complete aircraft	-	-	40,000	Ambient	-	2-38

B.2. SEA LEVEL STATIC THRUST STANDS (Industry Owned)

Organization Location Facility Name  INDUSTRY OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Thrust Measuring Capacity (lb <sub>f</sub> )	Total Temp. (°R)	Mass Flow Rate (lb/sec)	Page
AiResearch Mfg. Co. Torrence, California Engine Test Facility (Torrence Site B)	Enclosed, sea level static test cell	23Wx22Hx83L (Bellmouth diam: 3)	-	10,000	Ambient	-	2-2
Allison Indianapolis, Indiana Sea Level Test Cell No. 1	Enclosed, sea level static test cell	18 diam x 48L (Test cell)	-	40,000	Ambient	420 (Induced)	2-8
AVCO Lycoming Div. Stratford, Connecticut Ambient Test Cell T-14 & Tempered Air Test Cell D-4	Enclosed, sea level test cell with or without ram air	14Wx14Hx60L (Test cell)	-	10,000	520 to 590	200+ (Induced)	2-10
Boeing Company Boardman, Oregon Boardman Engine Test Site	Open air, sea level static test stands (B-1, B-2 and B-3)	-	-	25,000 (B-1 & B-3) 100,000 (B-2)	Ambient	-	2-12
Boeing Company Marysville, Washington Tulalip Engine Test Site	Open air, sea level static test stands (T-1 & T-2)	-	-	50,000 (T-1 & T-2)	Ambient	-	2-14
Boeing Company Wichita, Kansas Turbojet/Turbofan Engine Test Stand	Open air, sea level static test stand	-	-	30,000	Ambient	-	2-16
Curtiss-Wright Corp. Woodridge, New Jersey Sea Level Test Cell No. WX38	Enclosed, sea level static test cell	30Wx30Hx90L (Test cell)	-	50,000	Ambient	300 (Induced)	2-18
General Dynamics Convair Division San Diego, California Sea Level Engine Test Cells Nos. 4 & 5	Enclosed, sea level static test cells	Not Available	-	30,000	Ambient	275 (Induced)	2-20
General Dynamics Fort Worth Division Fort Worth, Texas Propulsion Systems Test Stand	Enclosed, sea level static test cell & semi-open test cell	20Wx32H (Test cell)	-	20,000	Ambient	-	2-22
General Electric Co. Peebles, Ohio Acoustic Facility (Site IV-D)	Open air, sea level static test stand	-	-	100,000 (Thrust frame capacity)	Ambient	-	2-24
General Electric Co. Peebles, Ohio Crosswind & Anti-Icing Facility	Outdoor test stand with cross- wind air supply	-	-	100,000 (Thrust frame capacity)	Ambient	-	2-26

B.2. SEA LEVEL STATIC THRUST STANDS (Industry Owned) (Continued)

Organization Location Facility Name  INDUSTRY OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Thrust Measuring Capacity (lb <sub>f</sub> )	Total Temp. (°R)	Mass Flow Rate (lb/sec)	Page
General Electric Co. Peebles, Ohio Endurance Test Stand	Open air, sea level static test stand	-	-	100,000 (Thrust frame capacity)	Ambient	-	2-28
General Electric Co. Evendale, Ohio Static Sea Level Test Cell No. 5	Enclosed, sea level static test cell	20Wx20H (Test cell)	-	100,000 (Thrust frame capacity)	To 610	2500 (Induced)	2-30
Grumman Aerospace Corporation Long Island, New York Engine Test Facility	Enclosed, sea level static test cell	15Wx35L (Test cell)	-	50,000	Ambient	-	2-32
LTV Aerospace Corp. Dallas, Texas Sea Level Engine Test Cell No. 3	Enclosed, sea level static test cell	32Wx16Hx44L (Test cell)	-	50,000	Ambient	-	2-34
Lockheed-Georgia Co. Marietta, Georgia Sea Level Engine Test Stand No. 1	Open air, sea level static test stand	-	-	60,000	Ambient	-	2-36
North American Rock- well/Columbus Div. Columbus, Ohio Sea Level Engine Test Cell	Enclosed, sea level static test cell	52Wx22Hx70L (Test cell)	-	50,000	Ambient	-	2-40
North American Rock- well/Los Angeles Div. Santa Susana, Calif. Propulsion Systems Test Facility	Sea level static test stands	Not Available	-	60,000	Ambient	-	2-42
Northrop Corporation Hawthorne, Calif. Engine Test Cell	Enclosed, sea level static test cell	30Wx19Hx100L (Test cell)	-	20,000	Ambient	-	2-44
United Aircraft Corp. E. Hartford, Conn. Sea Level Engine Test Stand No. X-8	Enclosed, sea level static test cell with heated air	33Wx33H Inlet Length: 55 (Test cell)	-	75,000	To 580	2000 (Induced)	2-46
United Aircraft Corp. E. Hartford, Conn. Sea Level Outdoor Test Stand No. X-314	Open air, sea level static test stand	-	-	100,000 (Thrust frame capacity)	Ambient	-	2-48
United Aircraft Corp. Windsor Locks, Conn. X-308 Outdoor Test Stand Acoustical Research	Open air, sea level static test stand	-	-	-	Ambient	-	2-50

B.3. SEA LEVEL TEST CELLS WITH RAM AIR (Government & Industry Owned)

Organization Location Facility Name  GOVERNMENT OWNED	Type Facility	Test Section Size (Dimensions in feet)	Mach Range	Thrust Measuring Capacity (1bf)	Total Temp. (°R)	Mass Flow Rate (1b/sec)	Page
Air Force-Marquardt Jet Laboratories Van Nuys, California Full Scale Sea Level Cell No. 3	Enclosed, sea level test cell (Free jet or direct connect)	10Wx8Hx40L (Free jet or bellmouth diam. to 2.67 ft)	To 3	90,000	To 1260	To 1100	3-4
Naval Air Propulsion Test Center Trenton, New Jersey Engine Sea Level Test Cell Facilities No. 1W and 2W	Enclosed, sea level test cells	23Wx14Hx56L	To .9	20,000	395-680	To 350	3-6
Ordnance Aerophysics Laboratory Daingerfield, Texas Sea Level Test Cell No. 1	Enclosed, sea level test cell	13.8Wx14Hx25.3L (Test cell)	Not Available	60,000	To 1060	To 300	3-8
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INDUSTRY OWNED							
AVCO Lycoming Div. Stratford, Connecticut Ambient Test Cell T-14 and Tempered Air Test 611D-4	Enclosed, sea level w/ambient ram, or tempered air	14x14x60L	Not Available	10,000	520-590	28 (Tem- pered)	2-10
General Electric Co. Evendale, Ohio Ram Test Cell No. 38	Enclosed, sea level test cell with or without ram air	20Wx19H (Test cell)	0-3.2	75,000 (Thrust frame capacity)	To 1210	400 (Ram air) 1200 (Induced)	3-2
United Aircraft Corp. E. Hartford, Conn. Ramjet Connected Pipe Test Facility	Enclosed sea level test cell	Max. engine model diameter: 1.25	Not Available	Not Available	To 1600	10-200	3-10
United Aircraft Corp. West Palm Beach, Fla. Sea Level Jet Test Stand No. A-1	Open air, sea level static test stand with altitude capability (Direct connect)	6 diameter (Test cell)	To 3.2	60,000	To 1460	To 265	3-12

B.4. PROPULSION WIND TUNNELS (Government & Industry Owned)

Organization Location Facility Name  GOVERNMENT OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Thrust Measuring Capacity (1bf)	Total Temp. (°R)	Mass Flow Rate (lb/sec)	Page
AEDC Arnold Air Force Station, Tennessee Propulsion Wind Tunnel - 16T	Closed-circuit, single-return, variable density, continuous flow	16Wx16Hx40L	.2-1.6	Not Available	410-620	Not Available	4-2
AEDC Arnold Air Force Station, Tennessee Propulsion Wind Tunnel - 16S	Closed-circuit, single-return, variable density, continuous flow	16Wx16Hx40L or 16Wx16Hx20L	1.5-4.75	Not Available	560-1110	Not Available	4-2
NASA Lewis Cleveland, Ohio 10-Foot by 10-Foot Supersonic Wind Tunnel	Closed or open circuit, variable density, continuous flow	10x10x40L	2-3.5	Not Available	500-785	Not Available	4-10
NASA Lewis Cleveland, Ohio 8-Foot by 6-Foot Supersonic Wind Tunnel	Closed or open circuit, continuous flow	8Wx6Hx39L	.8-2.1	Not Available	600-700	Not Available	4-12
NASA Lewis Plum Brook Station; Sandusky, Ohio Hyperersonic Tunnel Facility	High temperature, blowdown (Free jet or direct connect)	3.5 diam. free jet nozzles	5,6,&7	10,000 (Free jet) 20,000 (Direct connect)	To 4800	To 220	4-8
<hr/>							
INDUSTRY OWNED							
General Applied Science Laboratory Westbury, L.I., N.Y. High Temperature Combustion Tunnel	High temperature blowdown (Free jet or direct connect)	7 nozzles sizes to 1.28x1.28	1.2-7.7	Not Available	To 4500	To 40	4-4
General Applied Science Laboratory Westbury, L.I., N.Y. Pebble-Bed Heated Air Blowdown Wind Tunnel	High temperature blowdown (Free jet or direct connect)	7 nozzle sizes to 2.29x2.29	2.6-8.4	Not Available	To 5500	To 35	4-6

C.1. ALTITUDE TEST CELLS

AEDC AIRBREATHING ENGINE ALTITUDE TEST CELLS

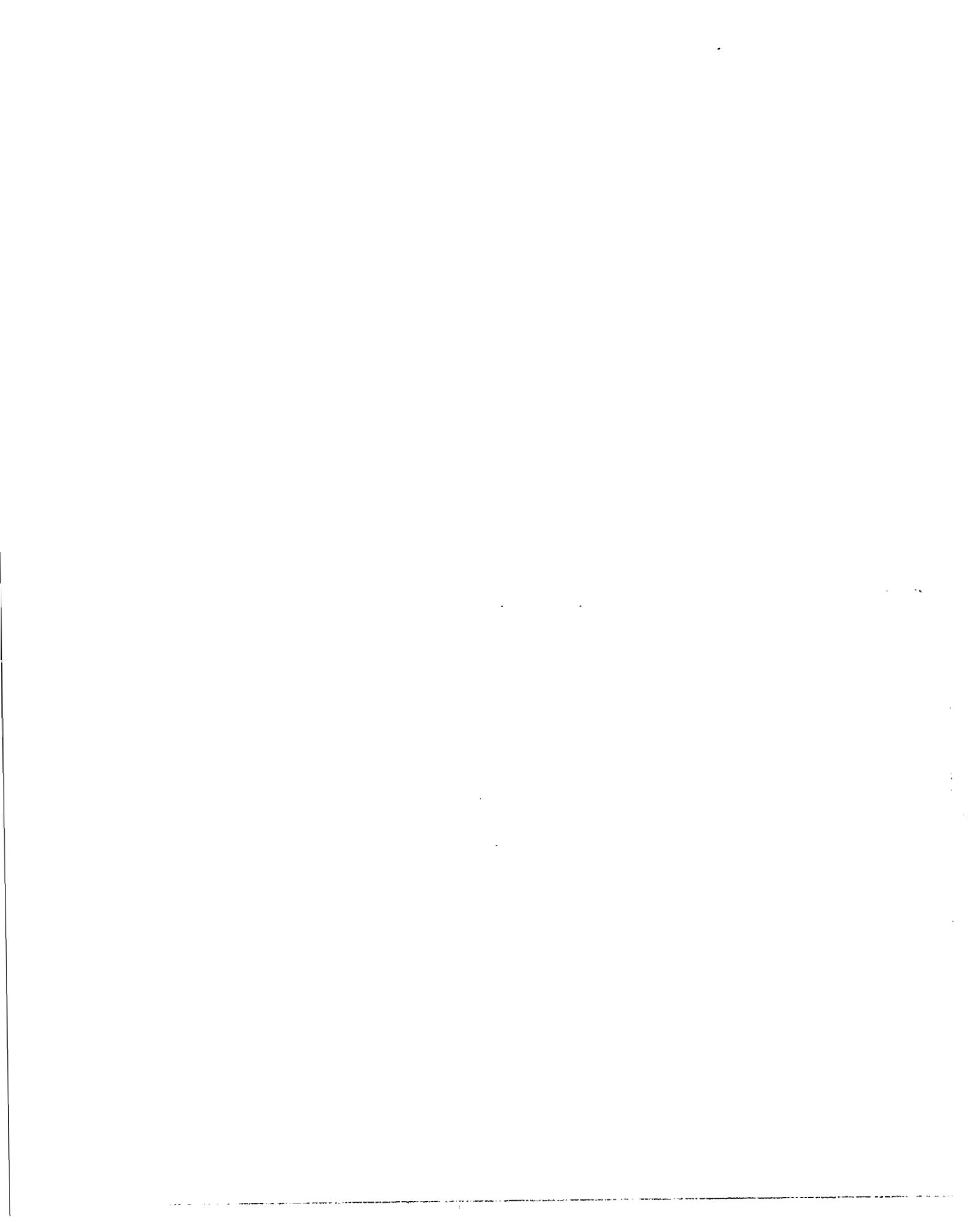
REPORTING INSTALLATION: Arnold Engineering Development Center (AEDC) Arnold Air Force Station, Tennessee 37389	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Air Force Systems Command
OTHER SOURCES OF INFORMATION: Test Facilities Handbook, AEDC 8th Edition, December 1969	LOCAL OFFICE TO CONTACT FOR INFORMATION: Director of Test (AET) Phone: (615) 455-2611, ext 625 or 645

INFORMATION ON THE FOLLOWING FACILITIES:

Airbreathing Propulsion Test Unit  
Propulsion Altitude Test Cells (T-2, T-4, J-1, and J-2)  
Propulsion Research Test Bed (R-2B)

IS SUBJECT TO SPECIAL EXPORT CONTROLS. FURTHER INFORMATION MAY BE OBTAINED FROM:

Air Force Systems Command  
Arnold Engineering Development Center  
Arnold Air Force Station, Tennessee 37389

AIR FORCE AERO PROPULSION LABORATORY  
ALTITUDE TEST CELL NO. 1

REPORTING INSTALLATION: Air Force Aero Propulsion Laboratory Wright-Patterson Air Force Base Ohio 45433	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Technical Facilities Division
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: AMPD Phone: (513) 255-4430

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This facility has air supply and exhauster capacity suitable for testing turbojet engines (up to 3000 lb thrust) at high altitude throughout the subsonic, transonic and low supersonic speed range. The overall facility will cover Mach 1.5 between 15,000 and 50,000 ft with true temperature within this envelope. The test cell is connected to a cold air supply system which will provide 15 lb/sec of air, at atmospheric pressure, at -65°F continuously. Air at 100 psia (20 lb/sec), 315 psia (7.5 lb/sec) and 37 psia (32 lb/sec) is supplied to the test cell. The test section chamber is 10 ft in diameter by 17.3 ft long. Altitude exhaust conditions are achieved using a system of 4 centrifugal pumps connected in parallel or series.

**ALTERNATE FACILITIES:** An alternate altitude test cell is available.

**TESTING CAPABILITIES:** This turbojet altitude chamber is used to conduct altitude calibrations, high and low temperature qualification tests, altitude starting tests, control system evaluations, engine stall tests and many other investigations.

FACILITY COST HISTORY

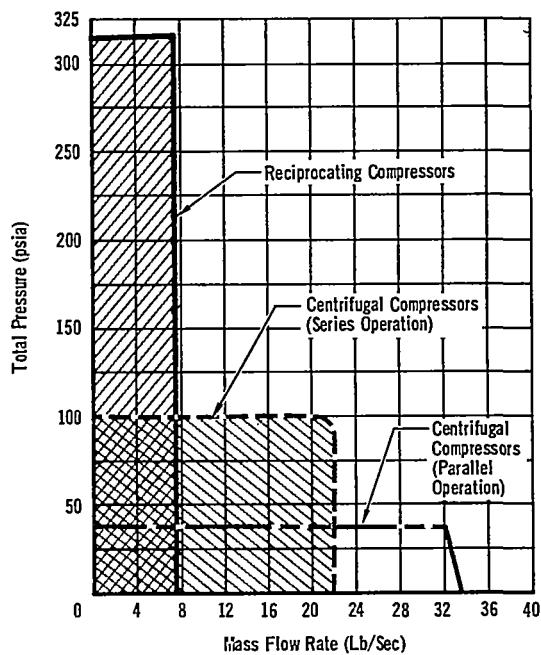
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$1150	CONSTRUCTION YEAR: N/A COST \$1,519K/cell ESTIMATED REPLACEMENT VALUE \$2,963K/cell
CONTRACTOR: Unknown	LOCATION:
IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC

(Not Available)

FACILITY PERFORMANCE DATA



Mach Range, with true temperature simulation: 1.5  
Total Temperature, with true temperature simulation ( $^{\circ}$ R): Ambient to 395  
Total Pressure (psia): 14.7 to 315  
Mass Flow Rate (lb/sec): Up to 32  
Maximum Run Time: Continuous  
Maximum Altitude (feet): 50,000  
Maximum Engine Thrust  
Measuring Capability (lb<sub>f</sub>): 3000

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range ( $^{\circ}$ F)
Hydrocarbons	800,000 gallons			Ambient

AIR FORCE AERO PROPULSION LABORATORY  
RAMJET COMBUSTION AND VISCOS MIXING FACILITIES

REPORTING INSTALLATION: Air Force Aero Propulsion Laboratory Wright-Patterson Air Force Base Ohio 45433	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: Technical Facilities Division
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: APMD Phone: (513) 255-4430

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** The two facilities described herein are serviced by the same compressed air and exhauster systems. Therefore, they are combined for purposes of description. Both facilities consist of test cell areas which are basically similar with certain utilities and services supplied to them. Altitude exhaust conditions are achieved with a system of 4 centrifugal pumps connected in parallel or series.

**TESTING CAPABILITIES:** Either facility can be operated in the free jet or direct connect mode and they can be utilized for various specialized purposes, depending upon what equipment is added. No data acquisition systems are included as part of these facilities.

**NOTE:** Cost History for the Viscous Mixing Facility is as follows: Construction Year: 1943; Cost, \$869,000; Contractor: Unknown; Estimated Replacement Value: \$1,855,800; Average Estimated Cost for Facility Operation (Typical 8 Hour Shift): \$900.

FACILITY COST HISTORY

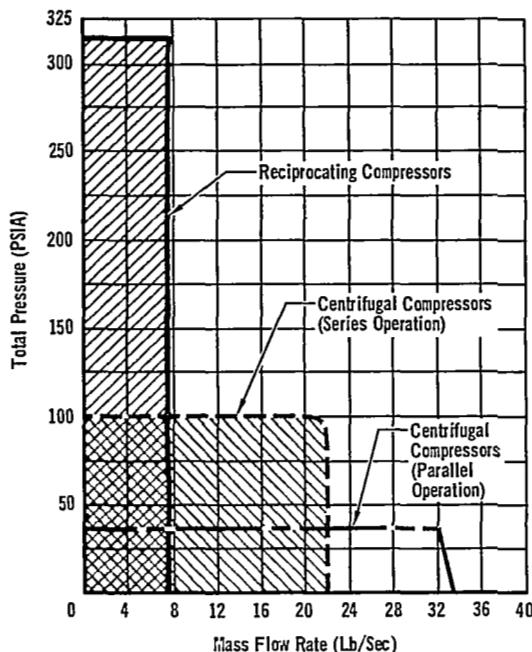
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$900	CONSTRUCTION YEAR: 1961 COST \$1,137,850 ESTIMATED REPLACEMENT VALUE \$2,321,600
CONTRACTOR: L. E. Stevens IMPROVEMENTS AND COSTS: (1961) Equipment modification, Cost, \$195,849.	LOCATION: Newport, Kentucky

PLANS FOR FACILITY IMPROVEMENTS: None.

SCHEMATIC

(Not Available)

FACILITY PERFORMANCE DATA



(Both Facilities)

Compressed Air

Total Pressure (psia): 52 to 315  
Mass Flow Rate (lb/sec): 7.5 to 32

Refrigerated Air

Total Pressure: Ambient  
Total Temperature: 380  
Mass Flow Rate (lb/sec): 15  
Nominal Flow  
Duration (sec): Continuous

Altitude (feet): 55,000 @ 3 lb/sec  
10,000 @ 80 lb/sec

(Viscous Mixing Facility  
Only w/Air Heater)

Total Pressure (psia): 315  
Total Temperature (°R): up to 1660  
Mass Flow Rate (lb/sec): .3 to 20

NOTE: The Air Heater is limited to 1460°R  
outlet temperature at air pressures  
exceeding 100 psi.

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
	None			

ALLISON ALTITUDE TEST CELL NO. 1

REPORTING INSTALLATION: Allison Division of General Motors P.O. Box 894 Indianapolis, Indiana 46206	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT:
OTHER SOURCES OF INFORMATION: Allison Brochure, "Research and Development Facilities", March 1968.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. J. S. Brody, Chief Test Engineer Phone: (317) 243-5155

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This direct connect altitude test cell has a test section 18 feet in diameter by 68 feet in length. The facility is designed to provide measured, ram airflow to 450 lb/sec with pressure and temperature control to the engine inlet. An exhaust system with a capacity in excess of 1,000,000 cfm is available for altitude simulation up to approximately 50,000 feet.

OTHER FACILITIES: Another test cell is available with identical test section dimensions as the subject test cell which provides the same ram airflow conditions but does not have the altitude simulation capability.

TESTING CAPABILITIES: The ram-air system for this test cell is designed to accommodate rapid transients in engine operation while maintaining constant inlet temperature. While operating at altitude conditions, aircraft lubrication and fuel systems can be evaluated. Refrigerated air conditions provide capability for demonstration of engine starting at sea level and altitude at reduced temperatures. Engine anti-icing capability and acceleration can also be demonstrated at these temperatures.

Facility-installed instrumentation monitors test conditions and engine functions and includes provisions for automated recording. Computer facilities are used for on-line data reduction.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: COST \$ ESTIMATED REPLACEMENT VALUE \$ Not Available
CONTRACTOR:	
IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: Not Available

SCHEMATIC

(Not Available)

FACILITY PERFORMANCE DATA

Facility Operating Envelope

(Not Available)

Mach Range: Not Available

Total Temperature, with true  
temperature simulation (°R): 395

Total Pressure (psia): Not Available

Mass Flow Rate (lb/sec): 450

Maximum Altitude (feet): 50,000

Maximum Run Time: Continuous

Maximum Engine Thrust  
Measuring Capability (lbf): 30,000

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	Not Available	Not Available	30,000 48,000 (reheat burner fuel flow)	Not Available

APPLIED PHYSICS LABORATORY PROPULSION RESEARCH LABORATORY  
(Scaggsville, Howard County, Maryland)

REPORTING INSTALLATION: Applied Physics Laboratory Johns Hopkins University 8621 Georgia Avenue Silver Spring, Maryland 20910	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aeronautics Division
OTHER SOURCES OF INFORMATION: Brochure, "The JHU/APL Propulsion Research Laboratory"	LOCAL OFFICE TO CONTACT FOR INFORMATION: PRL Office, Howard County Laboratory Scaggsville, Maryland Phone: (301) 953-7100, ext 2411

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** The Propulsion Research Laboratory (PRL) is designed to conduct experimental work on hypersonic airbreathing propulsion and re-entry studies. It is of the blowdown type, providing air at appropriate temperatures and pressures to simulate flight conditions correctly over a wide range of Mach numbers. The facility provides six test cells, four of which (Nos. 1, 2, 3 & 4), are of explosion resistant reinforced concrete construction. These cells measure 40 feet long by 12 feet wide by 10 feet high. The remaining two test cells, one larger (No. 5) and one smaller (No. 6), are not as strongly constructed and are used for less hazardous tests. Various free-jet propulsion tunnels are available within the test cells. In order of size, these are a variable-Mach number, free-jet tunnel using interchangeable throat sections (Mach 7 and 10 throats available) used with arc heaters, a Mach 5 tunnel used with a storage heater, and Mach 6 and Mach 2 free-jet ablation tunnels used with arc heaters. The direct connect mode is possible also to extend the flight simulation capability. The facility stores 56,000 lbs of air at 3000 psi which can be used at the test cells in the blowdown mode at pressures up to nearly 3000 psi and mass flows up to 100 lbs/sec. A smaller air supply stores air at 10,000 psi for use at the test cells at pressures up to 6000 psi. The process air can be heated by a variety of heaters: a storage-type heater using a stainless steel matrix provides temperatures up to 2160°R, while a vitiated air topping heater boosts this temperature to 3500°R; 10 MW arc heaters are available for a higher temperature regime, ranging up to about 9000°R.

**TESTING CAPABILITIES:** The PRL is used primarily as an advanced research and development tool, as opposed to operations such as routine engine qualification tests or quality control tests. The six test cells are designed for testing advanced supersonic combustors, scale models of airbreathing or hybrid-rocket engines, fuel injection and ignition models, and other components. The test set ups, including propulsion tunnels and arc heaters, are installed in the test cells in accordance with the requirements for the individual testing programs.

A new state-of-the-art instrumentation and control system has been installed which will log data at the rate of 30,000 samples/sec using 54 wide band channels plus 128 narrow band channels, and provide both manual and programmed control of 100 open-loop and 128 closed-loop control lines. Shadowgraph and Schlieren apparatus is available for flow visualization.

\* Note Below: The cost history is for the complete Propulsion Research Laboratory, including 6 test cells.

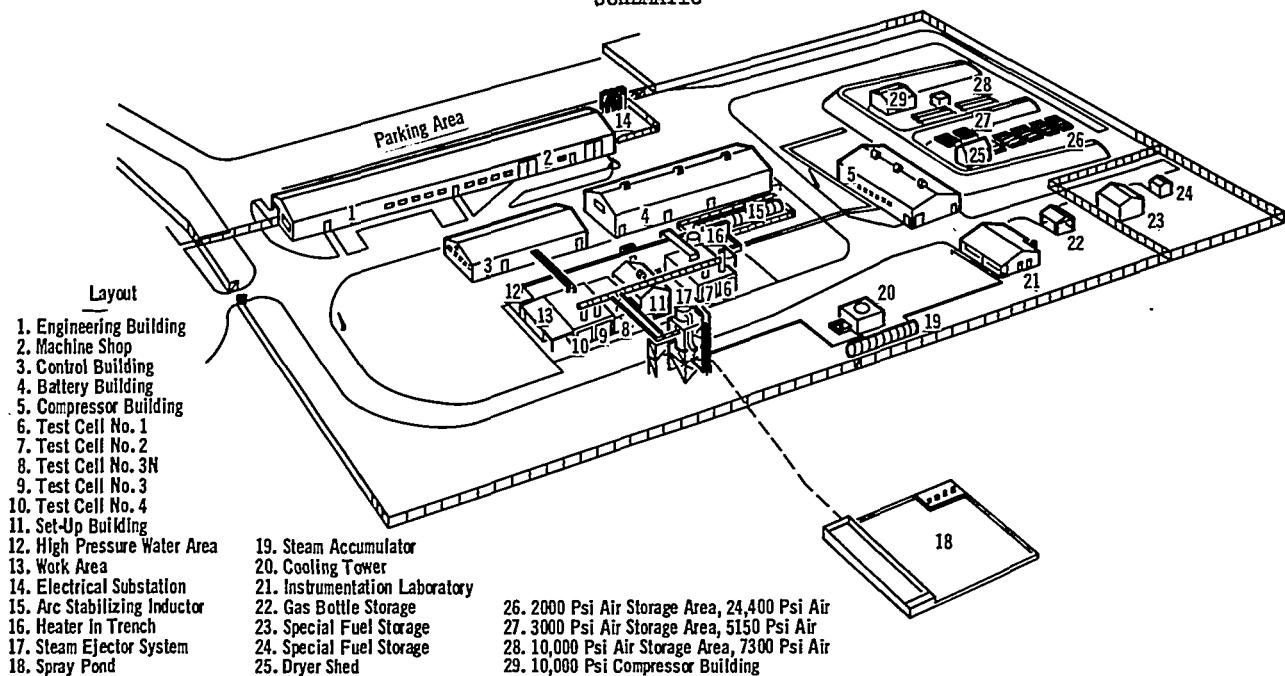
\*\* Note Below: Does not include \$2,523,000 worth of surplus equipment furnished to the contractor or installed after initial construction. The five acres of land on which the PRL is built is part of the 365 acre APL site owned by JHU, and its value is not included.

FACILITY COST HISTORY \*

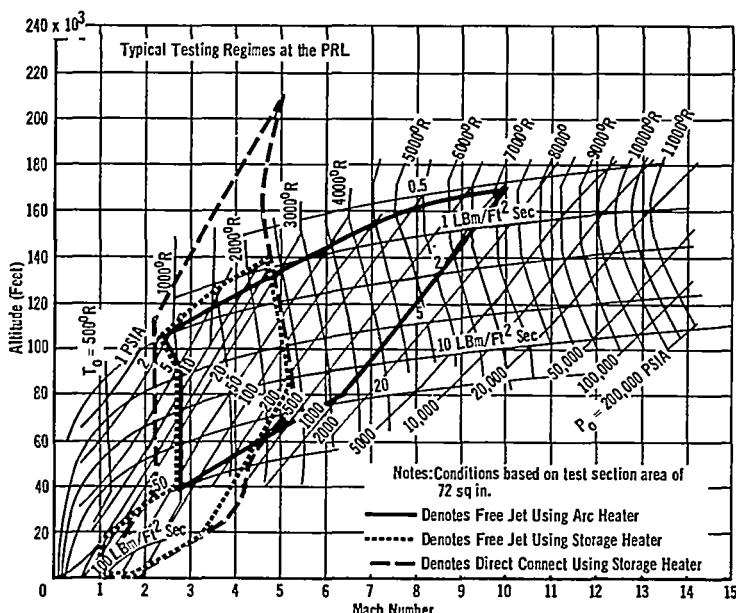
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$2000	CONSTRUCTION YEAR: 1961 COST \$2,370,000 ** ESTIMATED REPLACEMENT VALUE \$6,588,850
CONTRACTOR: William T. Lyons, Inc.	LOCATION: Baltimore, Maryland
IMPROVEMENTS AND COSTS: (1963) Test Cell 5, Cost \$140,450; (1966) 2000 psi cooling water system, Cost \$34,000; (1966) Control Building extension, Cost \$30,000; (1969) New instrument and control system, Cost \$242,000; (1961-69) Miscellaneous improvements and surplus equipment, Cost \$1,249,000.	

PLANS FOR FACILITY IMPROVEMENTS: Modify Test Cell 5 to provide full-scale free jet hypersonic engine testing. Double the flow capacity of the vacuum system.

## SCHEMATIC



**FACILITY PERFORMANCE DATA**



Mach Range:	1 to 10
Total Temperature, with true temperature simulation (°R):	
Storage air-heater:	1700
Vitiated air boost:	3500
Total Temperature (°R)	
10 MW arc-heater:	9000
Total Pressure (psia):	Up to 6000
Mass Flow Rate (lb/sec):	100
Maximum Altitude (feet):	200,000
Nominal Flow Duration (sec):	100 to 240
Maximum Engine Thrust	
Measuring Capability (lb <sub>f</sub> ):	Not Applicable

#### ENGINE FUEL SUPPLY CAPABILITY

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	As req. for test	As req. for test	As req. for test	As req. for test
Borane Mixtures	As req. for test	As req. for test	As req. for test	As req. for test
Hydrogen, others as required	As req. for test	As req. for test	As req. for test	As req. for test

## GE ALTITUDE TEST CELL NO. 43

REPORTING INSTALLATION: General Electric Company Cincinnati, Ohio 45215	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Test Facilities Engineering Evendale, Ohio
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Test Facilities Engineering Phone: (513) 243-4964

## DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** Altitude Test Cell No. 43 is part of a complex of two main buildings or structures, one housing two test chambers (Nos. 43 and 44) and their respective control rooms, and the other housing the air circulating machinery and their prime movers. The test cells are large welded steel "walk in" test chambers 17 ft in diam and 56 ft long, provided with 30 ft access doors that retract into the floor for ease in engine installation, and also with man doors for access when the main doors are closed. The air circulating machinery is comprised of three variable speed, variable output modular units, each made up of an 17,000 hp LM1500 industrial gas turbine drive, and two 10-stage axial flow compressors. Each module is capable of delivering 200 lb/sec of flow at 45 psia when used as a ram air supply, and will pull 330,000 scfm when used in the exhaust mode to produce reduced pressure conditions. These modules are connected through six-foot diam piping to a single 32,000 hp synchronous motor driven compressor, which has 300 lb/sec flow capacity in ram mode, and 250,000 scfm capacity in the exhaust mode. Additional existing plant capacity is also tied to this new facility contributing another 100 lb/sec of ram flow. Altogether, the total capacity adds up to 1000 lb/sec on ram or approximately 1,000,000 scfm in the exhaust mode. When both modes are used together, that is in "ram" plus "exhaust", the capacity is 400 lb/sec ram and 1,000,000 scfm exhaust. Other major items include: (1) An air cooler used to cool compressor discharge air, removing the heat of compression both for ram mode and for cooling between stages of the new compressor modules and the existing 32,000 hp compressor when in two stage exhaust mode; and (2) A 300 million Btu per hour direct fired air heater to boost 1000 lb/sec of air from 300°F to 650°F, using either natural gas or the JP fuels.

**ALTERNATE FACILITIES:** As noted above, an alternate facility (No. 44) is available, with capabilities identical to the subject test cell.

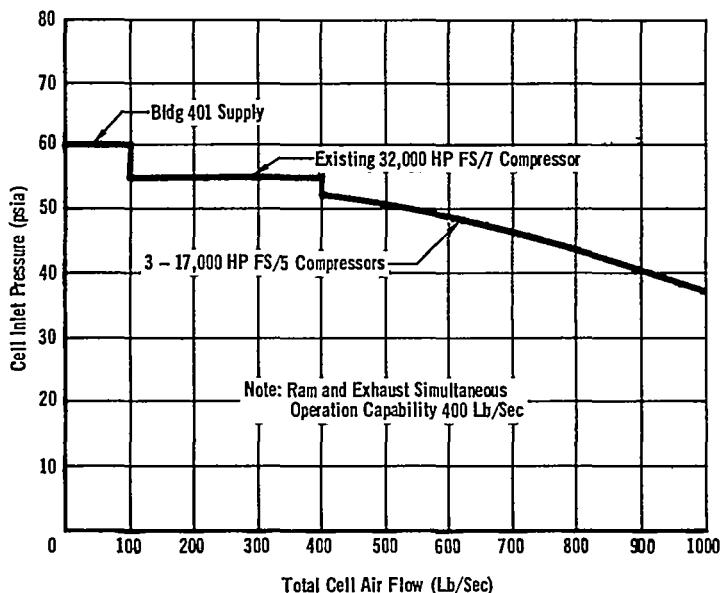
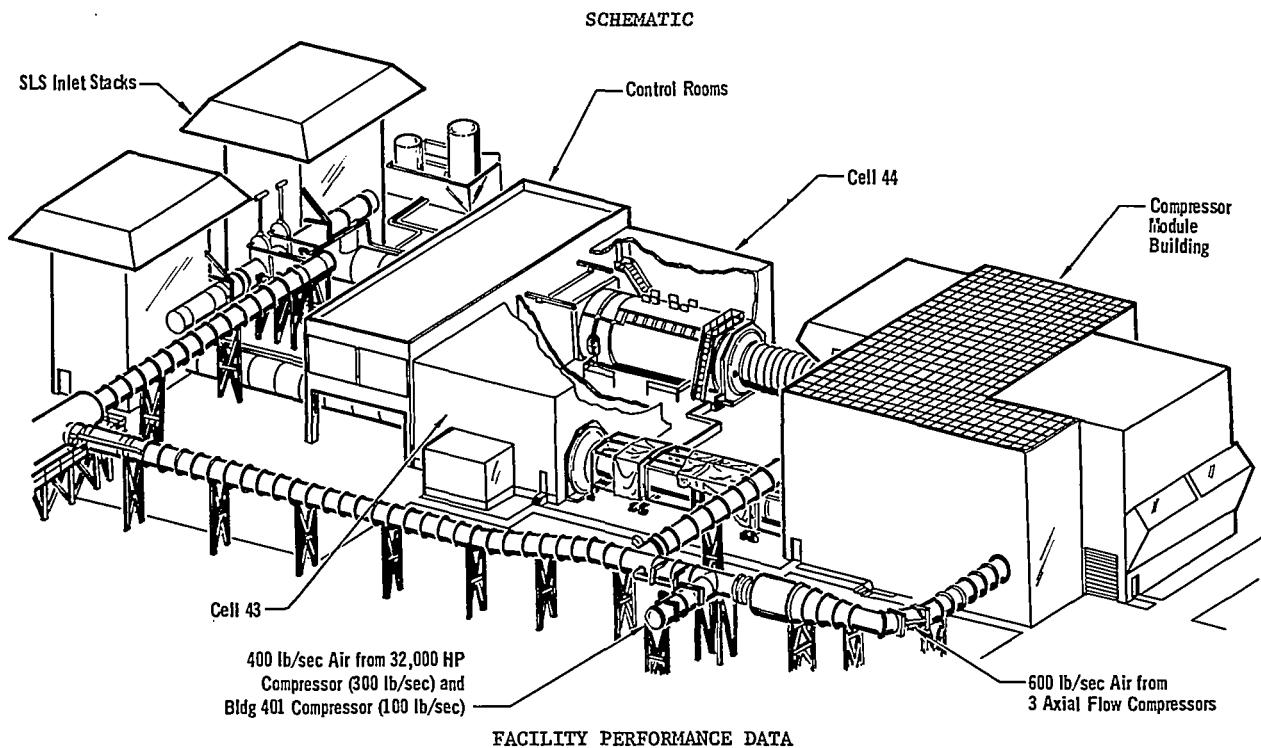
**TESTING CAPABILITIES:** The two test cells (Nos. 43 and 44) are operated from an adjacent control room serving both chambers and equipped with operating and display instrumentation similar to the sea level test cells. Each chamber is connected to the Building 500 Instrumentation Data Room, and has performance measurement recording capabilities of 392 temperatures, 400 pressures, 10 frequencies (fuel flow and speeds), 24 bridge channels, 10 vibration channels and 21 liquid pressure channels. The Automatic Data Handling (ADH) equipment has the capability of recording transient data; up to 400 analog channels can be recorded at speeds from 200 to 10,000 channels per second. Engine performance data and engine "flying" conditions are available within three minutes after the initiation of a normal ADH reading.

**OTHER SERVICES:** Dry air is provided at 100 psi; Water, 4000 gal/min; Electrical power: 100V, 60 Hz; 440V, 3 Phase; 110V, 400 Hz; 28 Vdc.

## FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1968 COST \$ ESTIMATED REPLACEMENT VALUE \$ Not Available
CONTRACTOR:	LOCATION:
IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: None



Mach Range:	Up to 3
Total Temperature (°R):	
Direct fired air heater:	760 to 1110
Short-term refrigerated air (°R):	410
Total Pressure (psia):	5 to 45
Mass Flow Rate (lb/sec):	
Ram only:	1000
Ram plus exhaust:	400
Run Time:	Continuous
Maximum Altitude (feet):	80,000
Maximum Engine Thrust Measuring Capability (lb <sub>f</sub> ):	100,000 (Thrust frame capacity)

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Delivery Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons Natural Gas	850,000 gal Pipe Line (Industrial)	0-90	144,000	Ambient

**MARQUARDT FULL SCALE ALTITUDE CELL NO. 8**  
 (Air Force-Marquardt Jet Laboratory, Van Nuys)

REPORTING INSTALLATION: The Marquardt Corporation 16555 Saticoy Street Van Nuys, California 91409	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Test and Facilities Department
OTHER SOURCES OF INFORMATION: Marquardt Publication MP 1487	LOCAL OFFICE TO CONTACT FOR INFORMATION: Manager, Test and Facilities Department Phone: (213) 781-2121, ext 1203

**DESCRIPTION AND TESTING CAPABILITIES**

**FACILITY DESCRIPTION:** This altitude test cell has a test section which is 14 feet in diameter by 80 feet in length with a 30 foot side opening door. The angle of attack capability is +20° to -10°. A variety of free jet axisymmetric nozzles or direct connect bellmouths are available for positioning at the engine inlet. The available diameter sizes range from .58 to 2.67 feet. The test air may be clean-air heated or selected for vitiated heating (by a SUB heater) with oxygen replenishment available. The exhaust gases, which may be scrubbed, are ducted to centrifugal compressors at up to 250,000 CFM. Water for the cooling of the test item and exhaust gases is provided from a common industrial water system.

**ALTERNATE FACILITIES:** An alternate altitude test cell (No. 2) is available which can provide inlet total conditions of 215 psia and 5000°R with true temperature Mach number simulation from 1 to 6. Test Cell No. 2 is 12 feet in diameter and 80 feet long with an end opening door.

**TESTING CAPABILITIES:** This facility can be used for (1) complete engine testing or (2) engine components and auxiliary systems testing. Engine component testing can be provided for afterburners, combustors, and compressors. Exhaust nozzles, inlets, and variable geometry control also may be tested.

Engine dynamic simulation is achieved by engine variable geometry control, engine fuel control, or free stream variation. All three methods are controlled by remote electrical or hydro-pneumatic systems. Shadowgraph, TV, and motion picture facilities are available for flow visualization.

Both test cells (Nos. 2 & 8) are connected to a central computer controlled digital/analog data acquisition system with 189 channels of data (10K samples/sec). The data reduction and dynamic data recording capabilities are provided at the same location.

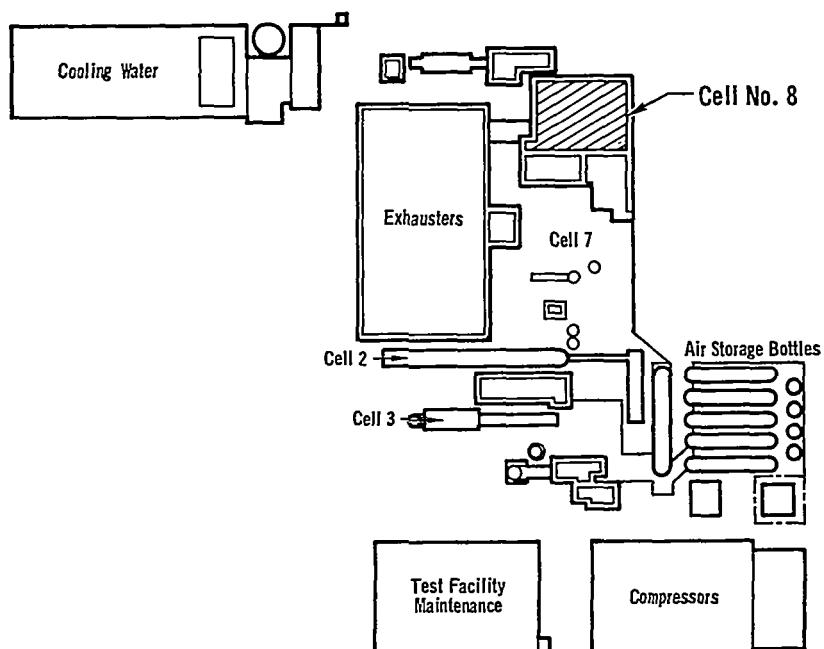
**OTHER SERVICES:** Service air is provided at 125 psia from a shop air system; Hydraulic services, at 1000 psia from a central system.

**FACILITY COST HISTORY**

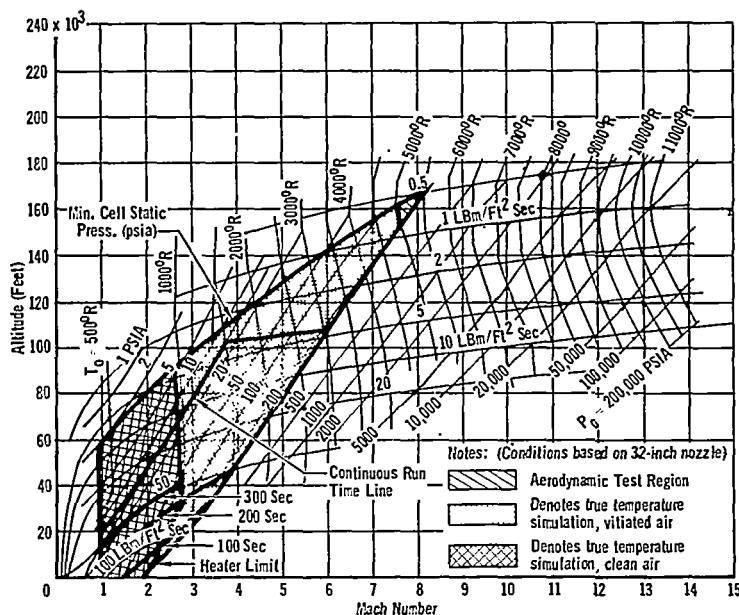
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$3570 (First Shift)	CONSTRUCTION YEAR: 1956 COST \$1,700,000 ESTIMATED REPLACEMENT VALUE \$3,000,000
CONTRACTOR: A & E: Norman Engineering Company Moffatt and Nichol, Inc.	LOCATION: Los Angeles, California
<b>CONSTRUCTION:</b> Paul W. Speer	
<b>IMPROVEMENTS AND COSTS:</b> (1960) Boundary layer bleed system, Cost \$85,000; (1960) High pressure vitiated heater system, Cost \$100,000; (1960) Storable propellant system, Cost \$130,000; (1968) Data system (projected cost), Cost \$300,000.	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range, with true temperature simulation: .8 to 7.6

Total Temperature, with true temperature simulation ( $^{\circ}\text{R}$ ): 5000

Total Temperature ( $^{\circ}\text{R}$ )  
 Vitiated Air: 5000  
 Clean Air: 920

Total Pressure (psia): 215

Mass Flow Rate (lb/sec)  
 Pressurized Air: 800  
 Indirect Fired Air: 650  
 Vitiated Air: 130

Maximum Altitude (feet): 170,000

Maximum Run Time: Continuous

Maximum Engine Thrust Measuring Capability (1b<sub>f</sub>): 100,000

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (1b <sub>m</sub> /hr)	Temperature Range ( $^{\circ}\text{F}$ )
Hydrocarbons	58,000 gallons	14.7	72,000	Ambient
Cryogenic Hydrocarbons	Available in portable tanks only.			
Liquid Hydrogen	Available			

MARQUARDT SMALL SCALE ALTITUDE CELL NO. 7  
 (Air Force-Marquardt Jet Laboratory, Van Nuys)

REPORTING INSTALLATION: The Marquardt Corporation 16555 Saticoy Street Van Nuys, California 91409	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Test and Facilities Department
OTHER SOURCES OF INFORMATION: Marquardt Publication MP 1487	LOCAL OFFICE TO CONTACT FOR INFORMATION: Manager, Test and Facilities Department Phone: (213) 781-2121, ext 1203

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This altitude test cell has a test section which is 6 feet in diameter by 30 feet in length. Free jet or direct connect tests can be conducted or the cell can be operated in the sea level mode. The nozzle bellmouth exit diameter is 1 foot. The test air may be heated either through a tube and shell heater or through a single or multiple system of vitiated (SUE) heaters. The air supply is ducted at 600 psia to the cell through a 14-inch diameter air line connected to the 600 psia air storage system. The exhaust gases may be collected at sea level or at subambient pressures in the Cell 2-8 exhaust system. An air-to-air ejector is also provided to perform in series with the main exhaust system. Exhaust gas scrubbing and water cooling is also provided. The maximum exhaust flow rate is 250,000 cfm.

TESTING CAPABILITIES: This cell is used for the aerodynamic and combustion testing of small scale modules of airbreathing engines and/or their components. Engine components testing can be accomplished for combustors or inlets for ramjet engines.

Engine dynamic simulation is achieved by engine variable geometry control, engine fuel control, or free stream variation. All three methods are controlled by remote electrical or hydro-pneumatic systems. A TV system is available for test monitoring.

The test cell is connected to a central computer controlled digital/analog data acquisition system with 189 channels of data (10K samples/sec). The data reduction and dynamic data recording capabilities are provided at the same location.

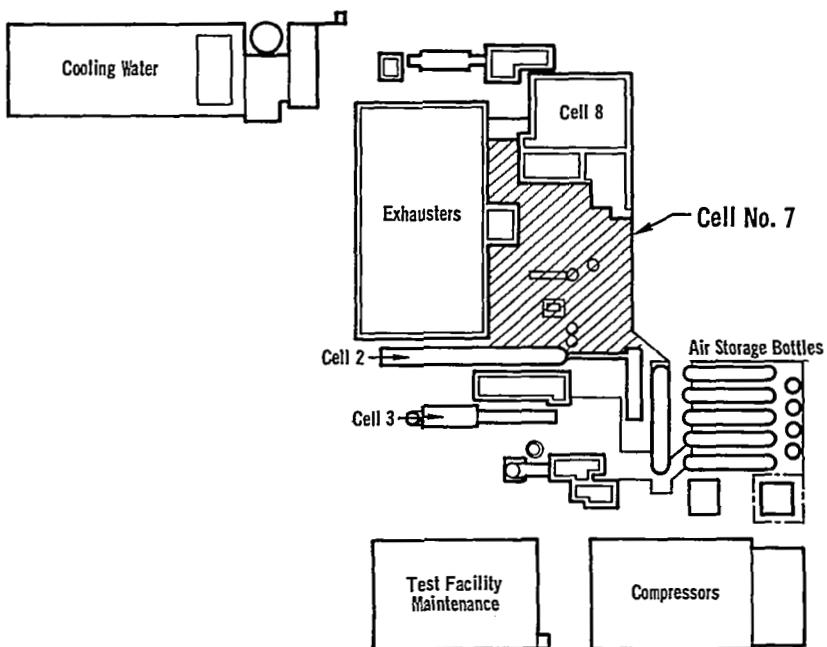
OTHER SERVICES: Service air is provided at 125 psia from a shop air system; Hydraulic services, at 1000 psia from a central system.

FACILITY COST HISTORY

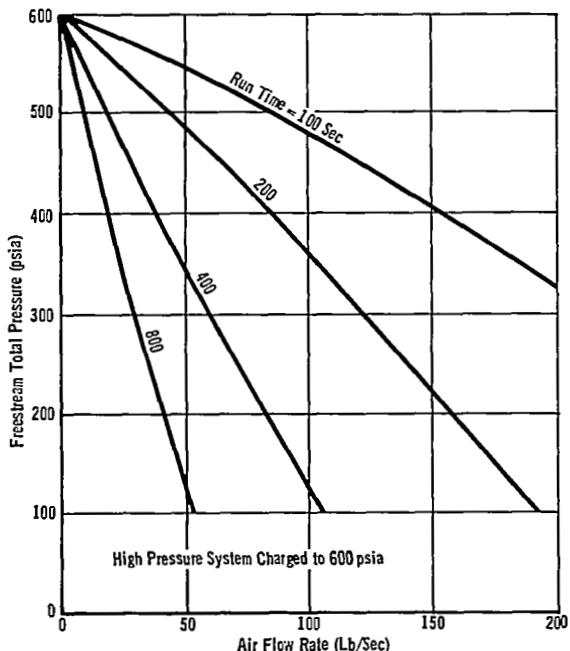
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$2960 (First Shift)	CONSTRUCTION YEAR: 1956 COST \$160,000 ESTIMATED REPLACEMENT VALUE \$500,000
CONTRACTOR: The Marquardt Corporation	LOCATION: Van Nuys, California
IMPROVEMENTS AND COSTS: (1962) 600 psi air system connection, Cost \$125,000; (1968) Gaseous hydrogen connection, Cost \$10,000; (1968) Gaseous oxygen connection, Cost \$7000; (1967-69) Vitiated heaters (various configurations), Cost \$70,000; (1969) Central data recording system connection, Cost \$20,000.	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: Not Available  
 Total Temperature ( $^{\circ}$ R)  
 Vitiated Air: 5000  
 Clean Air: 960  
 Total Pressure (psia): 600  
 Mass Flow Rate (lb/sec): 200  
 Maximum Altitude (feet): Not Available  
 Run Time: varies w/flow  
 Maximum Engine Thrust  
 Measuring Capability (lb<sub>f</sub>): 35,000

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range ( $^{\circ}$ F)
Hydrocarbons	Receivers or portable tanks furnished for specific test requirements			
Cryogenic Hydrocarbons				
Liquid Hydrogen				

NASA LEWIS ALTITUDE TEST CELL NO. 1

REPORTING INSTALLATION: NASA Lewis Research Center 21000 Brookpark Road Cleveland, Ohio 44135	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Airbreathing Engines Division, Propulsion Systems Laboratory
OTHER SOURCES OF INFORMATION: NACA RM E55A04 - Turbojet	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Airbreathing Engines Division Org Code: 9800 Phone: (216) 433-4000, ext 208

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an altitude test facility with test section dimensions of 14 feet in diameter by 24 feet in length. The exhaust section measures 12 feet in diameter by 37 feet in length. A variety of air supply and conditioning devices are available. These include: (1) Combustion air compressors with a maximum capacity of 450 lb/sec at 45 psig; (2) a Booster Compressor with a capacity of 450 lb/sec at 150 psig; (3) Three combustion air heaters, each of which will heat air at 125 lb/sec from 40°F to 600°F; and (4) An air refrigeration expansion turbine with a 112 lb/sec capacity which can reduce air temperature by 100°F. Altitude exhaust capacity is 2,200,000 CFM. Two parallel air dehydrator units each can reduce air dryness to 9 grains H<sub>2</sub>O/lb air for an air flow rate of 125 lb/sec at 45 psig at 40°F. A desiccant type dryer can reduce 155 lb/sec air flow to 1 grain H<sub>2</sub>O/lb air.

ALTERNATE FACILITIES: An alternate test cell (No. 2) is available with identical capabilities as those of the subject test cell.

TESTING CAPABILITIES: This facility is used to support full scale turbojet or ramjet engine tests under simulated altitude conditions with controlled temperature and pressure to determine such characteristics as: Thrust, fuel consumption, air flow, stall limits, blow-out limits, operating temperatures, acceleration characteristics, vibration and starting characteristics.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	CONSTRUCTION YEAR: ESTIMATED REPLACEMENT VALUE \$ Not Available LOCATION:	COST \$
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PLANS FOR FACILITY IMPROVEMENTS:

SCHEMATIC

(Not Available)

FACILITY PERFORMANCE DATA

Facility Operating Envelope

(Not Available)

Mach Range, with true temperature simulation: Not Available

Total Temperature, with true temperature simulation (°R): Not Available

Total Temperature, vitiated air (°R): 1060

Mass Flow Rate (lb<sub>m</sub>/sec): 450

Total Pressure (psia): to 465

Maximum Altitude (feet): Not Available

Maximum Run Time: Continuous

Maximum Engine Thrust Measuring Capability (lb<sub>f</sub>): Not Available

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Not Available				

NASA LEWIS ENGINE RESEARCH BUILDING

REPORTING INSTALLATION: NASA Lewis Research Center 21000 Brookpark Road Cleveland, Ohio 44135	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Multi-Organizational Control For General Information, See Below
OTHER SOURCES OF INFORMATION: NASA, "Technical Facilities Catalog", Vol. I, NHB 8800.5, March 1967	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Facilities Operations Division Org Code: 7300 Phone: (216) 433-4000, ext 250

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** The original Engine Research Building (Bldg 5) constructed in 1942 has subsequently been enlarged with the addition of: (1) the Compressor and Turbine Research Facility in 1944 (Bldg 23, West Wing), (2) the Exhauster Equipment Wing in 1946 (Bldg 37, Northwest Wing), and (3) the Southwest Wing Extension in 1947 (Bldg 38). The total complex includes 65 test cells of various sizes with altitude capability. The original Bldg 5 contains 54 test cells.

Bldg 23 contains 6 test cells, the largest of which are 57 feet wide by 20 feet high by 80 feet in length. These cells contain bed plates, and piping systems for refrigerated air, combustion air, and altitude exhaust.

Bldg 37 contains 1 test cell and 4 centrifugal exhausters which are part of the altitude exhaust system for the total complex.

Bldg 38 contains 4 altitude test cells, 2 of which are 10 feet in diameter by 60 feet in length. The cells contain piping systems for refrigerated air and exhaust heaters for large combustion research equipment.

The altitude exhaust system contained in Bldgs 5 and 37 includes the following exhaust compressors: (2), 600 hp; (4), 1000 hp; (3), 2500 hp; and (1), 4000 hp. These provide exhaust capacities at 50,000 feet altitude of 48 lb/sec at 1.69 psia; 20,000 feet, 105 lb/sec at 6.75 psia; and 10,000 feet, 87 lb/sec at 10.1 psia. The atmospheric exhaust system capabilities are: (1) Center Section; 43K cfm at 1.47 psia; (2) Bldg 23; 166K cfm at 4.91 psia; and (3) SE and SW Wings; 11K cfm at 1.47 psia.

**TESTING CAPABILITIES:** The Engine Research Building complex conducts tests on complete jet engines and components such as compressors, turbines, compressor and turbine components, and combustion devices. Ion engine components are also included.

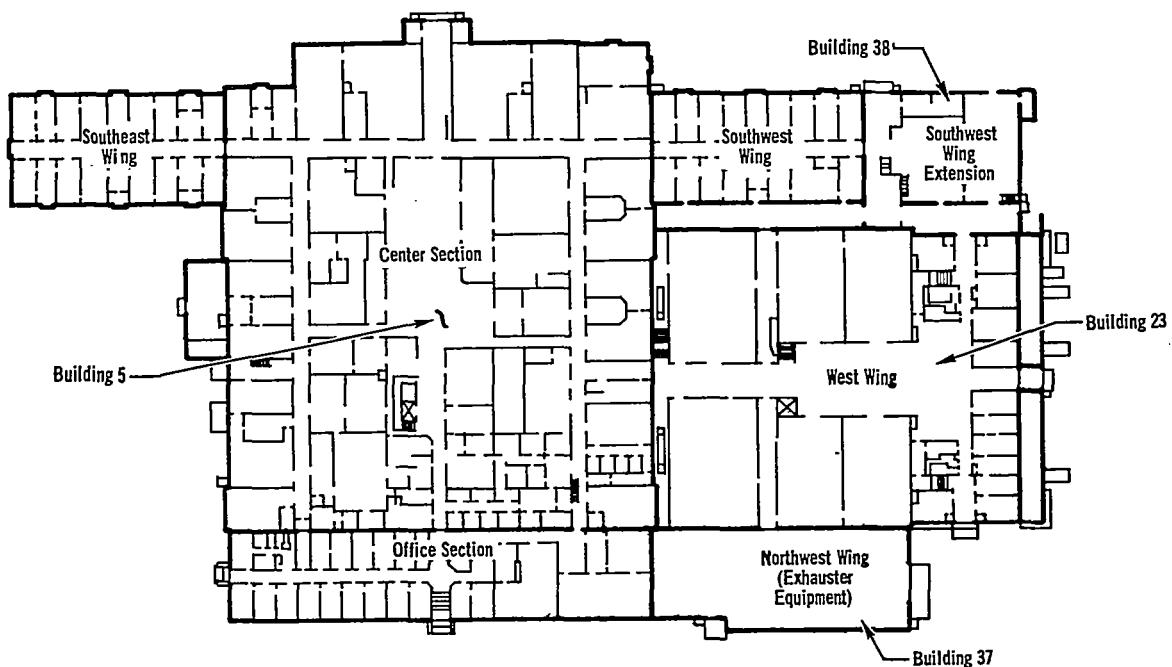
**OTHER SERVICES:** Service air: 3 compressors are available which can provide air at 3.2 lb/sec at 125 psig; Cooling (low pressure) air, 50K CFM at 27.5 psia; Dowtherm System, 14,000,000 Btu/hr; and Steam, 100 psig.

FACILITY COST HISTORY

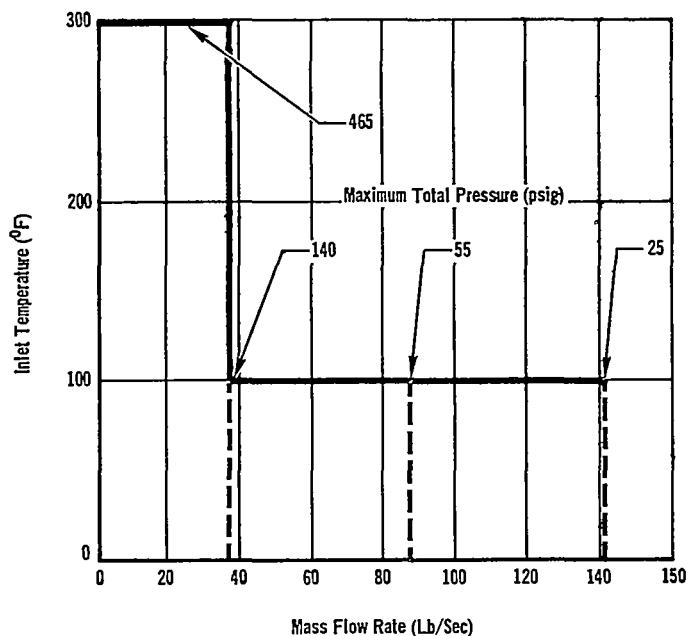
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1942-47 COST \$9,033,000 ESTIMATED REPLACEMENT VALUE \$ Not Available LOCATION:
CONTRACTOR: IMPROVEMENTS & COSTS: Total costs through 1967 are \$14,236,000.	

PLANS FOR FACILITY IMPROVEMENTS: None.

SCHEMATIC



FACILITY PERFORMANCE DATA



**Total Temperature ( $^{\circ}\text{R}$ )**  
 Heated Air: 560 to 760  
 Refrigerated Air: 480 @ 80 lb/sec  
  
**Total Pressure (psia):** up to 465  
  
**Mass Flow Rate (lb/sec):** 141  
  
**Maximum Altitude (feet):** 50,000  
  
**Run Time:** Continuous  
  
**Maximum Engine Thrust**  
**Measuring Capability (lbf):** Not Available

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery ( $\text{lb}_m/\text{hr}$ )	Temperature Range ( $^{\circ}\text{F}$ )
Not Available				

NAVAL AIR PROPULSION TEST CENTER  
ENGINE ALTITUDE TEST CELL FACILITY NO. 3E

REPORTING INSTALLATION: Naval Air Propulsion Test Center P.O. Box 176 Trenton, New Jersey 08628	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aeronautical Turbine Department (NAPTC)
OTHER SOURCES OF INFORMATION: (1) NAPTC, "Aeronautical Turbine Department Test Facilities Description"; (2) "Navy Tech. Facility Register", NAVMATP-3999, 1968.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Aeronautical Turbine Department Phone: (609) 882-1414, ext 239

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This altitude test cell is operated in the continuous mode using direct instream air heaters. The cell test section measures 17 feet in diameter by 30 feet in length. Altitude exhaust conditions are achieved using a system of variable speed centrifugal compressors and test cell diffusers. To establish the full range of temperatures, there are two separate heat exchangers involved. One is a steam heater capable of heating 350 lb/sec airflow to 810°R. The second heater is an oil fired boost heater capable of 300 lb/sec airflow at 1110°R that can provide temperatures as high as 1660°R at lower airflows. The test cell would require modifications to operate beyond 1110°R to the 1660°R level. Maximum continuous exhaust temperature is 3960°R with a pressure range from .39 psia to sea level. The engine exhaust temperature is reduced to 660°R by a waste heat boiler type exhaust gas cooler.

ALTERNATE FACILITIES: Two alternate test cells (Nos. 1E and 2E), similar to cell No. 3E but slightly smaller, are also available. Test section dimensions for the two test cells are identical at 14.5 feet in diameter by 18 feet in length. Maximum airflow of 350 lb/sec is attainable. The total pressure range is from .83 to 29.5 psia while the total temperature range is 395 to 780°R with a maximum allowable engine exhaust temperature of 3960°R.

TESTING CAPABILITIES: This facility can be used to conduct verification of contractor's guarantee points, determination of engines operating envelopes, establishment of transient performance, windmill relight tests, high and low temperature starting and operation, water ingestion tests, engine icing tests, and inlet pressure distortion tests. Engine instrumentation is standardized with all other test cells to provide quick disconnect couplings to mate with quick disconnect panels on the engine test stand in the test cell. Test instrumentation capability is provided through three groupings: (1) General monitor instruments, (2) Steady-state instrumentation, and (3) Transient instrumentation. The facility is connected to a central on-line data acquisition and computation system with type-out capability and a tape storage of engine performance data. The facility has the potential to be used as an environmental chamber, and a small rocket engine test chamber of limited capacity.

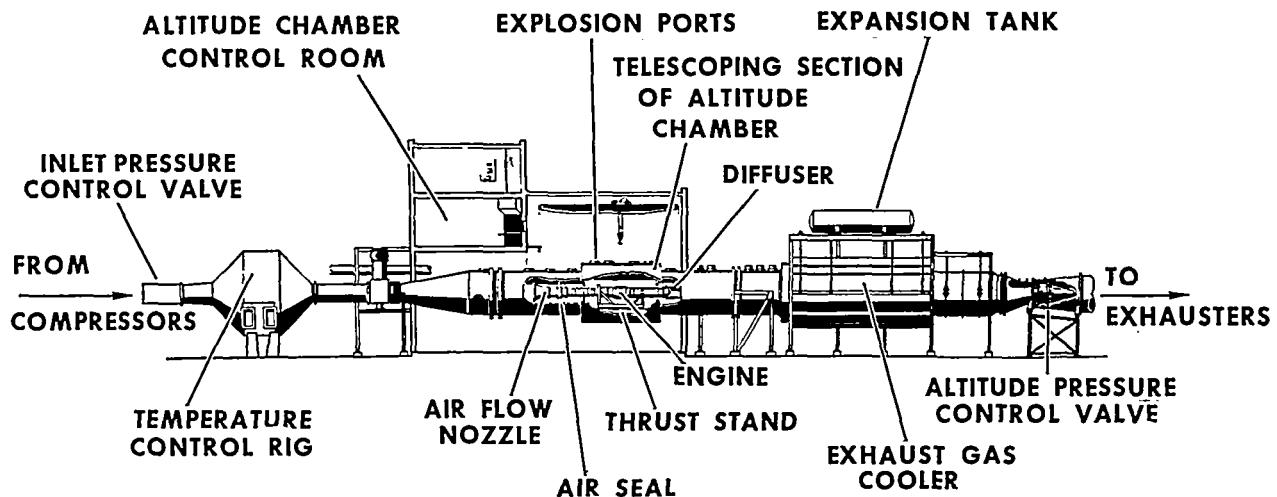
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1962 COST \$6,120,000* ESTIMATED REPLACEMENT VALUE \$6,487,000
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	

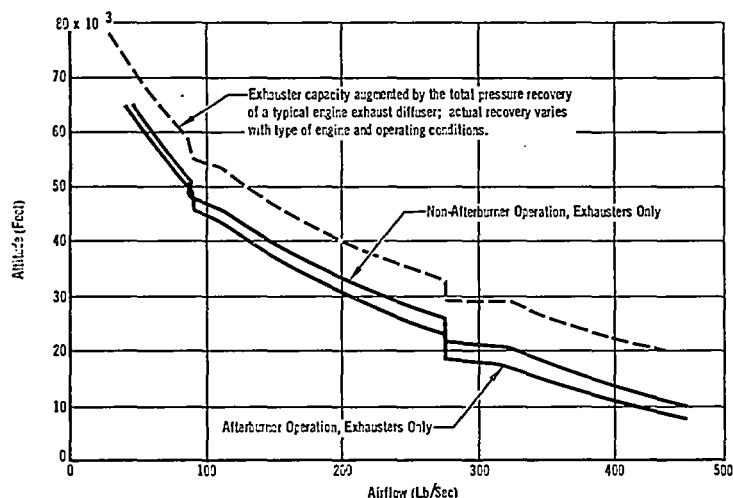
\* Cost pertains to Test Cell 3E only.

PLANS FOR FACILITY IMPROVEMENTS: Design work is being done to increase the capacity of the engine exhaust gas ejector-diffuser which will increase altitude capability. Design work is underway for provision of increased inlet pressure capability for high ram testing of future engines.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range, with true temperature simulation: up to 3.0  
 Total Temperature, with true temp simulation ( $^{\circ}$ R): 395 to 1660  
 Mass Flow Rate ( $lb_m$ /sec): 550  
 Maximum Run Time: Continuous  
 Total Pressure (psia): .83 to 29.5  
 Maximum Altitude (feet): 80,000  
 Maximum Engine Thrust  
 Measuring Capability ( $lb_f$ ): 50,000

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery ( $lb_m$ /hr)	Temperature Range ( $^{\circ}$ R)
Hydrocarbons	450K gal for all test cells	75		-70 to +150

NAVAL AIR PROPULSION TEST CENTER  
ENGINE MULTIPURPOSE TEST CELL FACILITY NO. 3W

REPORTING INSTALLATION: Naval Air Propulsion Test Center P.O. Box 176 Trenton, New Jersey 08628	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aeronautical Turbine Department (NAPTC)
OTHER SOURCES OF INFORMATION: (1) NAPTC, "Aeronautical Turbine Department Test Facilities Description"; (2) "Navy Tech Facilities Register", NAVMAT P-3999, 1968.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Aeronautical Turbine Department Phone: (609) 882-1414, ext 239

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This test cell, which was built to provide altitude-environmental testing of large turboprop engines, is 33 feet wide by 33 feet high by 196 feet long. It is connected to the conditioned air and exhauster systems. Capacity is shown in the Facility Performance Data listing on the opposite page.

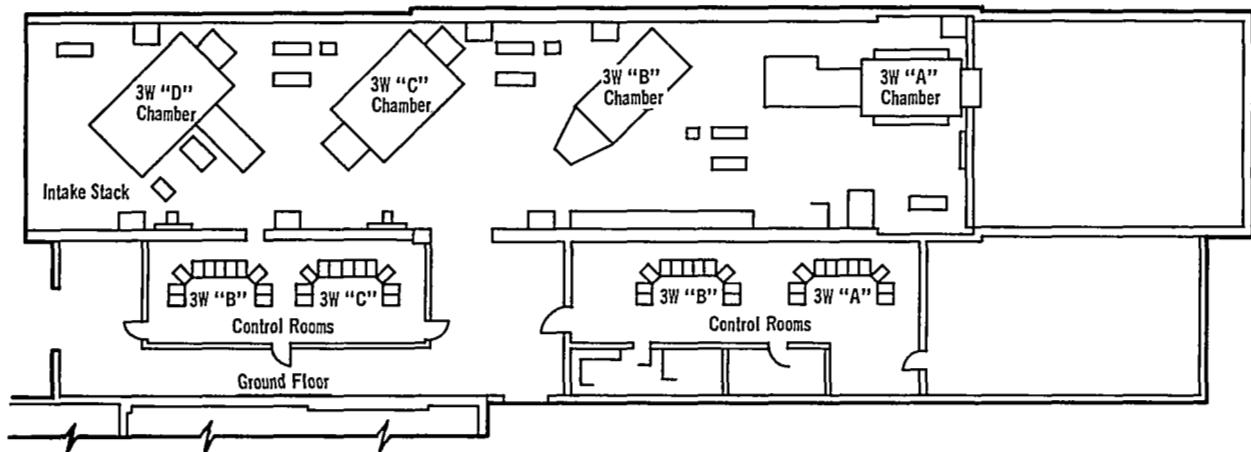
TESTING CAPABILITIES: This facility can be used to conduct verification of contractor's guarantee points, determination of engine's operating envelopes, establishment of transient performance, windmill relight tests, high and low temperature starting and operation, inlet pressure distortion tests, and tests involving in-flight nacelle fires. Test instrumentation capability is provided through three groupings: (1) General monitor instruments, (2) Steady-state instrumentation, and (3) Transient instrumentation. Engine instrumentation is standardized with all other test cells to provide quick disconnect couplings to mate with quick disconnect panels on the engine test stand in the test cell.

FACILITY COST HISTORY

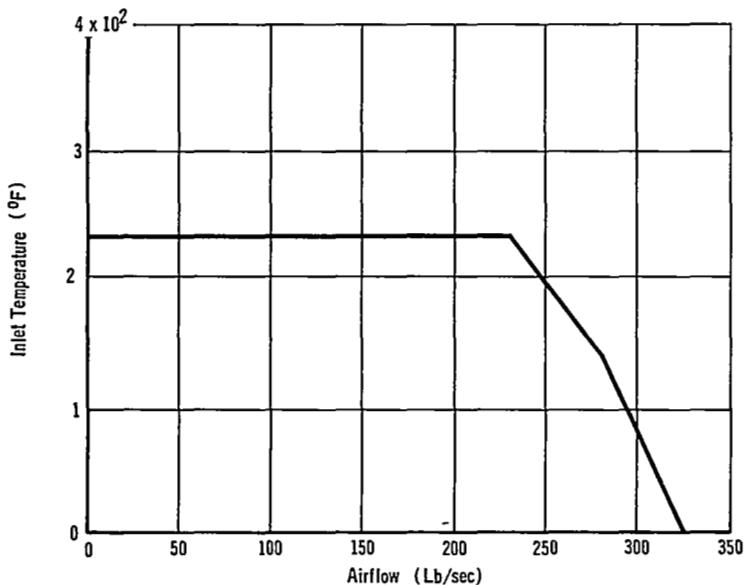
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1955 COST \$1,266,000 ESTIMATED REPLACEMENT VALUE \$1,645,000
CONTRACTOR:	LOCATION:
IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: Conversion of this facility to accommodate planned Navy small gas turbine engine programs is in progress.

SCHEMATIC



FACILITY PERFORMANCE DATA



PERFORMANCE PARAMETERS

Mach Range:	Not Available
Total Temperature (°R):	395 to 680
Total Pressure (psia):	.83 to 29.5
Mass Flow Rate (lb <sub>m</sub> /sec):	325
Maximum Run Time:	Continuous
Maximum Altitude (feet):	80,000
Maximum Engine Thrust	
Measuring Capability (lbf):	Not Available

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Supply Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	450K gal for all test cells	75		-70 to +150

NAVAL MISSILE CENTER PROPULSION TEST LABORATORY

REPORTING INSTALLATION: Naval Missile Center (Code 5332) Point Mugu California 93041	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: Laboratory Department
OTHER SOURCES OF INFORMATION: (1) NMC, "Ordnance and Propulsion Facilities", (2) "Navy Tech Facility Capability Register", NAVMAT P-3999, 1968.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Ordnance and Propulsion Branch Code 5332 Phone: (805) 982-7846

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: There are two airbreathing propulsion direct connect test facilities available, the Preflight Test Pad and the Combustion Test Cell. The Preflight Test Pad measures 30 by 45 feet by 15 feet high. Maximum engine thrust measuring capabilities is 5000 lbs. The Air System is capable of supplying air to simulate flight conditions between Mach 1 and Mach 2.25 at sea level, and conditions to Mach 3.9 at altitude. Air flow rate is variable from 4 lbs per sec to 20 lbs per sec. Respective testing time is 40.75 minutes and 4.33 minutes. The Combustion Test Cell measures 8 by 16 feet by 9 feet high and is inactive. Current plans do not include its future use.

TESTING CAPABILITIES: An analog data recording system is available with 50 data channels. FM tape recorders and Viscicorders are used for dynamic data recording. A digital and analog data reduction system is available.

Engine components testing is possible for combustors. Applicable engine types are turbojets (dry), turboramjets, ramjets, and air augmented rockets.

OTHER SERVICES: Service air is available at 100 psia from a 15 ft<sup>3</sup> storage cell.

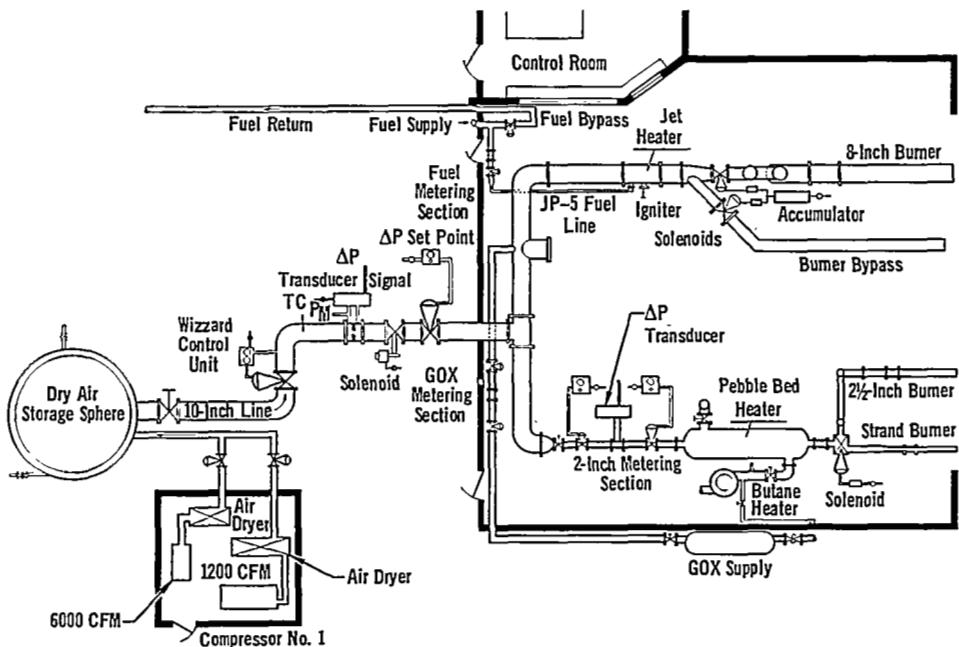
\*Note below: (a) Combustion Test Cell  
(b) Preflight Test Pad

FACILITY COST HISTORY

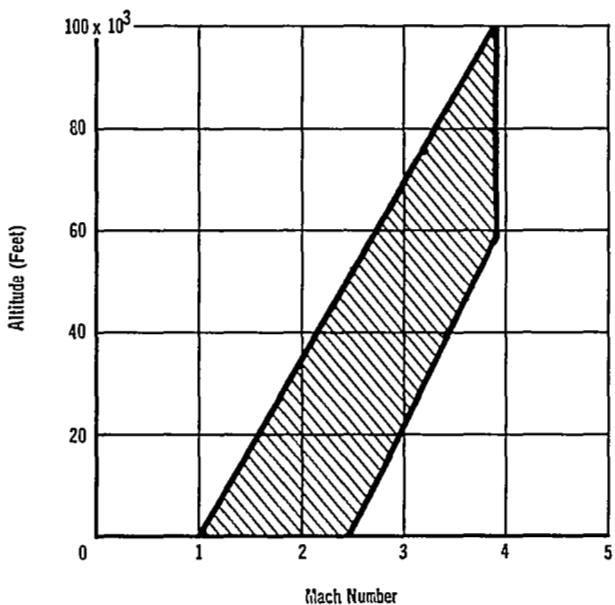
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): (a) \$762 (b) \$672	CONSTRUCTION YEAR: 1956 ESTIMATED REPLACEMENT VALUE \$400,000
CONTRACTOR: Ralph Parsons Co.	LOCATION: Los Angeles, California
IMPROVEMENTS AND COSTS: (1956) Blow down air supply, Cost \$100,000.	

PLANS FOR FACILITY IMPROVEMENTS: It is tentatively planned to relocate to a new area and increase the capabilities of the Preflight Test Pad.

SCHEMATIC



FACILITY PERFORMANCE DATA



Facility Name: Preflight Test Pad

Mach Range: 1 to 2.25 @ Sea level  
3.9 @ altitude given below

Total Temperature (°R): Ambient to 1040

Total Pressure (psia): 165

Mass Flow Rate (lb<sub>m</sub>/sec): 4 to 20

Nominal Flow Duration (sec): 260 to 2450

Altitude Range (feet): Sea Level to 100K

Maximum Engine Thrust  
Measuring Capability (lb<sub>f</sub>): 5000

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons Solid	4000 gallons 100 lb limit	Ambient	50,000	Ambient

ORDNANCE AEROPHYSICS LABORATORY  
ALTITUDE TEST CELL NO. 6

REPORTING INSTALLATION: Service Technology Corporation P.O. Box 748 Daingerfield, Texas 75638	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: Service Technology Corporation, a subsidiary of LTV Aerospace Corporation
OTHER SOURCES OF INFORMATION: OAL, "Facility Handbook", Report 655, 1967.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Service Technology Corporation Phone: (214) 656-2211, ext 343

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This altitude test cell can be operated in the continuous or intermittent blow-down mode using either indirect or direct instream air heaters. The cell test section measures 15 feet in diameter by 71 feet in length. Altitude exhaust conditions are achieved using a system of steam-jet ejectors and centrifugal compressors. In many free-jet test situations, normal fixed exhauster system capacity can be extended by using second throat diffuser pressure recovery devices. A large number of free-jet nozzles are available ranging in size from 6.1 to 50.28 inches in exit diameter. This cell also offers a selection of direct connect bellmouth inlets ranging in diameter from .333 to 4.00 ft. Various test specimen support systems are available including single and dual struts with provision of varying angle of attack up to 12°. Flow visualization is possible by means of available shadowgraph and schlieren systems.

**ALTERNATE FACILITIES:** An alternate test cell is available (No. 4) which can provide conditions nearly similar to those of the subject test cell. The test section is somewhat smaller, measuring 9.83 feet in diameter by 38.4 feet in length.

**TESTING CAPABILITIES:** This facility is used to conduct exploratory and advanced development in air-breathing propulsion systems, rockets, aerodynamic tests, aerothermodynamic tests, materials tests, accessories tests, quality assurance environmental tests, and spacecraft and satellite tests. Air-breathing propulsion tests can be made in either the free-jet or direct connect mode. The data acquisition system is built around two (on-site) Microsadic units, each having a total of 160 channels of data input. Sampling rates for the number two unit range as high as 2856 samples/sec for two channels of input to 117 samples/sec for 160 channels of input. The number one unit has sampling rates of one-third the first for 2 to 160 channels of input.

Engine components and auxiliary systems testing is possible for afterburners, combustors, compressors, fuel control systems, exhaust nozzles, heat exchangers, and inlets. Applicable engine types include turbojets (dry and w/afterburners), turbofans (dry and w/afterburners), turbofans (w/duct burning), turboramjets, ramjets, scramjets, convertible scramjets, and rockets (liquid and solid).

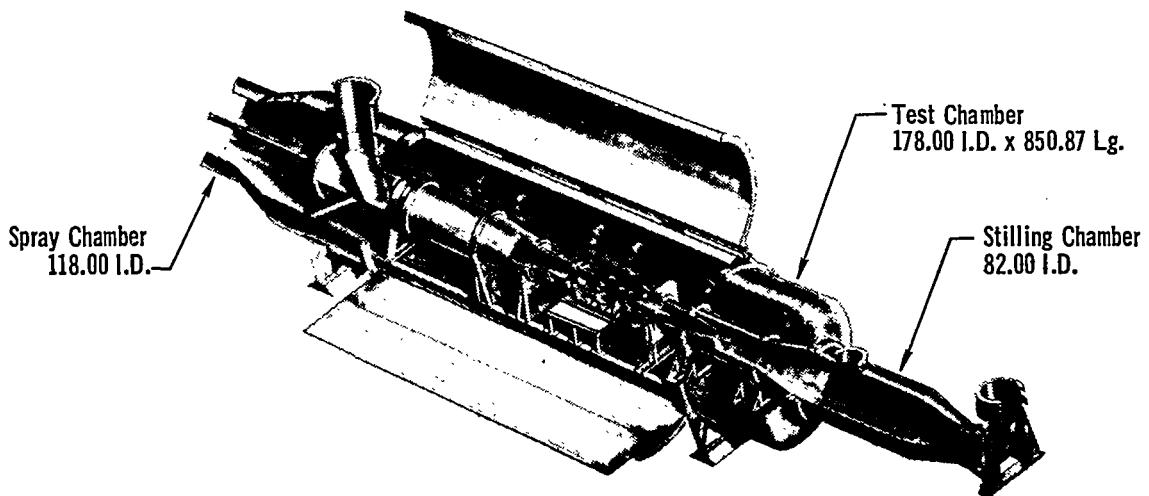
**OTHER SERVICES:** Dry air is available for 103 CFM at 105 psia; Service air, 10 lb/sec at 105 psia; Portable hydraulic systems, 0 to 23 gal/min at 3015 psia and 10 gal/min at 5015 psia; Steam, 270,000 lb/hr at 415 psia at 700°F; and Service water, 650 gal/min at 75 psia.

FACILITY COST HISTORY

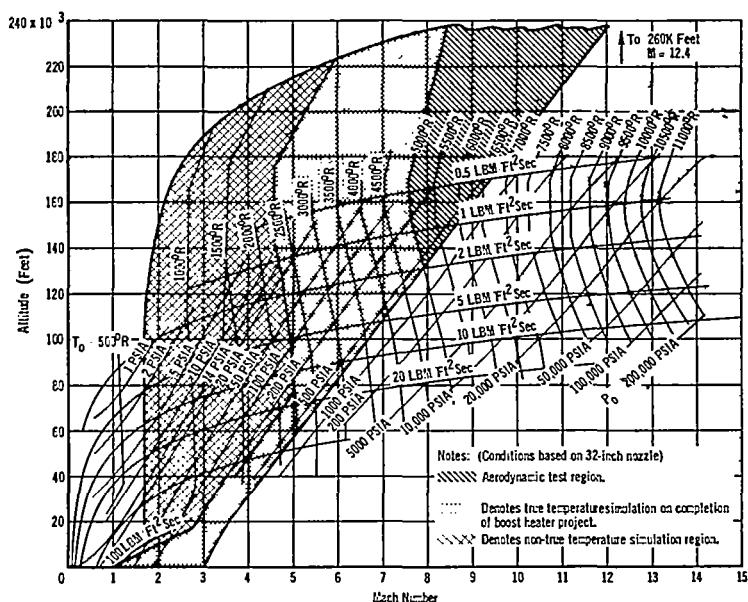
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$7920	CONSTRUCTION YEAR: 1957-58 COST \$3,913,253 ESTIMATED REPLACEMENT VALUE \$6,947,136
CONTRACTOR: Service Technology Corporation	LOCATION: Daingerfield, Texas
IMPROVEMENTS AND COSTS: (1960), Cost \$136,632; (1961), Cost \$257,973; (1963), Cost \$634,142; (1963), Cost \$540,248; (1965), Cost \$103,643.	

**PLANS FOR FACILITY IMPROVEMENTS:** Replace Intermittent Heater which was burned out and is not included in above totals.

SCHEMATIC



FACILITY PERFORMANCE DATA



PERFORMANCE PARAMETERS

Mach Range, with true temperature simulation:	1-5
Total Temperature, with true temperature simulation, (°R):	2260
Total Temperature, vitiated air, (°R):	3960
Total Pressure (psia):	515
Mass Flow Rate (lb/sec):	50-1600
Nominal Flow Duration (sec):	50-3000
Maximum Run Time: Continuous or 80 minutes (Blowdown)	
Maximum Altitude (feet):	230,000
Maximum Engine Thrust Measuring Capability (lbf):	60,000

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	600 in Run Tank	600 (Delivery Press @ Cell)	3884	90 (Maximum)
Gaseous Hydrogen	253,000 SCF	2500	5400	1000

## UAC ALTITUDE ENGINE TEST STAND NO. X-210

REPORTING INSTALLATION: United Aircraft Corporation Pratt and Whitney Aircraft Division Experimental Test Laboratories 400 Main Street, E. Hartford, Conn. 06108	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Experimental Test Department
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: J. L. Preston, Supvr, Experimental Test Facilities Facilities Office, Willgoos Laboratory Phone: (203) 565-8809

## DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This facility is a duct connected test stand designed and equipped for altitude testing of full scale engines, including those with afterburning devices, at various altitudes and flight speeds to Mach 3.0 conditions. A test section of 22.5 ft. length is available for mounting the engine which may be enclosed in a special capsule when required to obtain altitude ambient conditions around the engine. The stand is serviced by the centrally located Willgoos Laboratory compressed air, refrigerated air, heated air and exhauster systems.

**ALTERNATE FACILITIES:** There are five alternate altitude test cells at the Willgoos Laboratory designed to test full scale complete engines. Three of the stands have altitude chambers. Two are 42 ft. long and 12 ft. in diameter and one is 35 ft. long and 18 ft. in diameter. Test sections vary from 22 to 41 ft. in length. Inlet ducting to each of the test cells except X-217 provides heated, refrigerated and compressed air, while X-217, the largest cell, provides refrigerated inlet air up to 775 lb/sec at -10°F and subatmospheric pressures. All stands are connected to the exhauster system. Nine additional test stands are designed for testing engine components, including compressors, turbines, burners and afterburning devices.

**TESTING CAPABILITIES:** This facility is used to conduct developmental tests on current and advanced full scale engines and components. Equipment and instrumentation permit complete altitude performance analysis, endurance testing at altitude, strain gage analysis of rotating and stationary engine parts, engine inlet airflow distortion analysis and simulation of service problems for which true operating conditions must be simulated. A steady state data system serves this facility with 687 data channels which are transmitted to an on-line computer. Data and performance results are displayed on a line printer in the control room promptly after the data are requested. Transient data may be recorded by mobile van through an exterior panel. Four hundred data channels are available.

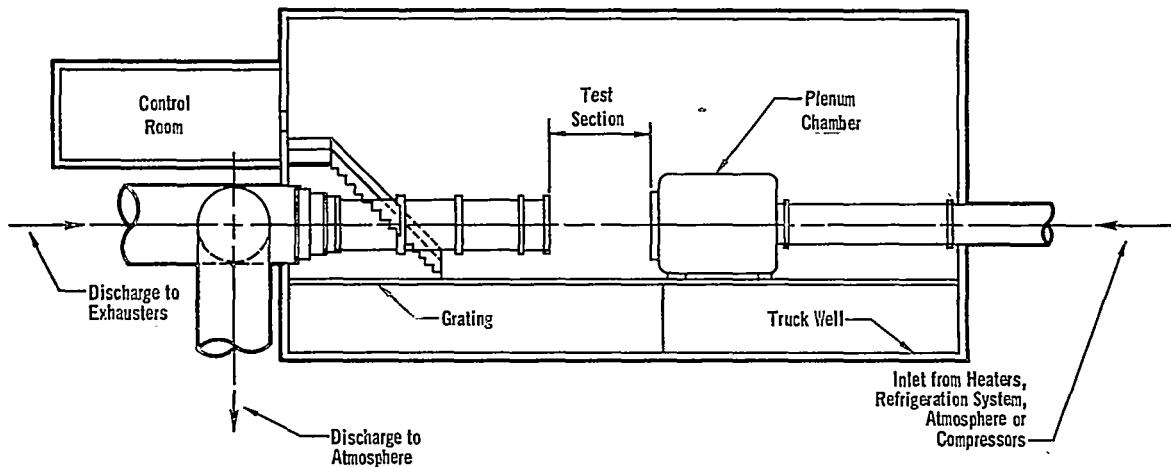
**OTHER SERVICES:** Chemically dried air is provided for 30 lb/sec at 14.7 psia; Service air, 3 lb/sec at 115 or 315 psia; Water, 240K gal/min at 50 psia; and Nitrogen, 52K ft<sup>3</sup> storage at 1800 psi, 450 psi service; Steam, 1,110,000 lb/hr at 435 psig, 740°F; and Electrical, kVA service.

## FACILITY COST HISTORY

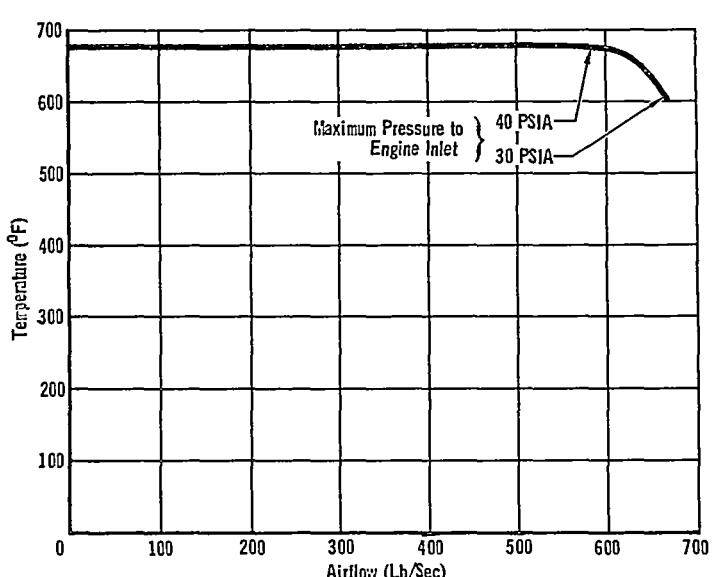
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not available	CONSTRUCTION YEAR: COST \$ ESTIMATED REPLACEMENT VALUE \$	Not available
CONTRACTOR:	LOCATION:	
IMPROVEMENTS AND COSTS: Not available		

PLANS FOR FACILITY IMPROVEMENTS: Not available

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 3.0

Total Temperature (°R): 425 to 1135

Total Pressure (psia): 40

Mass Flow Rate  
Heated Air  
(lb/sec): 584 @ 1135°R @ 40 psia

Mass Flow Rate  
Refrigerated Air  
(lb/sec): 100 @ 452°R @ 19 psia  
also: 40 @ 400°R

Mass Flow Rate  
Dry Air (lb/sec): 504 @ 40 psia

Maximum Run Time: Continuous

Maximum Altitude (feet): 90,000

Maximum Engine thrust  
Measuring Capability (lbf): 25,000

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons (JP Type)	8,000,000 gal (for all test cells)	Ambient	78,000	-65 to +165

UAC ALTITUDE TEST CELL NO. C-4  
(Florida Research and Development Center)

REPORTING INSTALLATION: United Aircraft Corporation Pratt and Whitney Aircraft Division Experimental Test Laboratories 400 Main Street; E. Hartford, Conn. 06108	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Experimental Test Department East Hartford, Connecticut
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: J. L. Preston, Supervisor, Experimental Test Facilities; Facilities Office, Willgoos Laboratory Phone: (203) 565-8809

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This altitude test stand (located at West Palm Beach, Florida) is operated in the continuous mode using either indirect or direct instream air heaters. The test section measures 6.5 feet in diameter by 20.7 feet in length. Altitude exhaust conditions are achieved using a system of steam jet ejectors and centrifugal exhausters. The normal fixed exhaust system capacity can be extended by using second throat diffuser pressure recovery devices. This is a duct connected stand utilizing an engine shroud. It can accept engines with thrusts to 60,000 lbs force. An exhaust stream periscope is available for flow visualization.

**ALTERNATE FACILITIES:** An alternate test cell (No. C-5) is available with capabilities nearly identical to cell No. C-4. Maximum engine thrust measuring capability is 60,000 lbf.

**TESTING CAPABILITIES:** This facility is used to conduct development tests on advanced airbreathing propulsion systems at simulated altitude conditions, including performance evaluation, endurance and inlet distortion. A centrally located Data Recording System is provided having the following capabilities: Pressure Channels: 200; Temperature Channels: 180; Transient Channels: 40; Continuous Monitoring Channels: 8. A computer is employed to present real time data in engineering units to the control room while test is in operation.

Engine components and auxiliary systems testing is possible for afterburners, combustors, and inlets. Applicable engine types are turbojets (dry and w/afterburners), turbofans (dry and w/afterburners), and turbofans (w/duct burning).

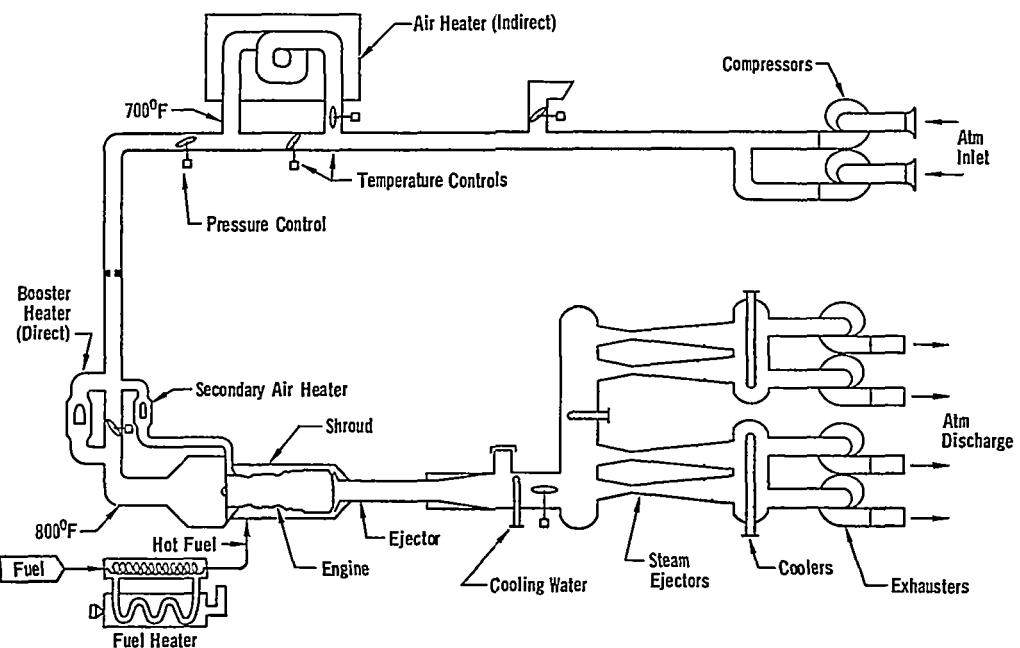
**OTHER SERVICES:** Instrument air is provided for .6 lb/sec at 115 psia and Shop air, 2 lb/sec at 115 psia.

FACILITY COST HISTORY

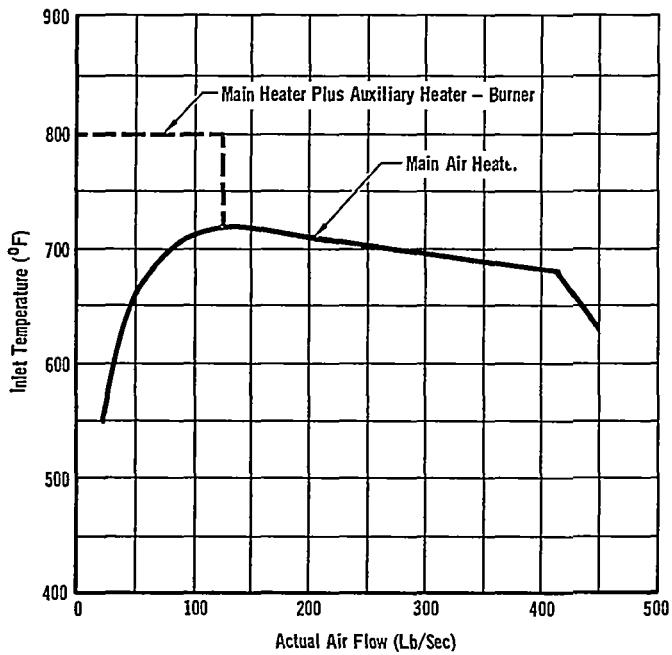
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: ESTIMATED REPLACEMENT VALUE \$	COST \$	Not Available
CONTRACTOR:	LOCATION:		
<b>IMPROVEMENTS AND COSTS:</b> Not Available			

PLANS FOR FACILITY IMPROVEMENTS: Not Available

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range, with true temperature simulation (°R): 3.2  
 Total Temperature, with true temperature simulation (°R): 1160  
 Total Pressure (psia): 50  
 Total Temperature, vitiated air (°R): 1260  
 Mass Flow Rate Dry Compressed Air (lb/sec): 480  
 Mass Flow Rate Heated Air (lb/sec): 125 @ 800°F  
 also 350 @ 700°F  
 Maximum Altitude (feet): 100,000  
 Run Time: Continuous (with steam ejectors, limited to 4 hours)  
 Maximum Engine Thrust  
 Measuring Capability (lbf): Not Available

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	2.3K gallons	80	100,000	Ambient
Hydrocarbons	Not Available	80	40,000	350



2. SEA LEVEL STATIC THRUST STANDS

**AIRESEARCH ENGINE TEST FACILITY**  
(Torrance Site B)

REPORTING INSTALLATION: AiResearch Manufacturing Company Garrett Corporation 2525 W. 190th Street Torrance, California 90509	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Los Angeles Division Laboratory Department 94
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Same as Reporting Installation Phone: (213) 323-9500, ext 1280

**DESCRIPTION AND TESTING CAPABILITIES**

**FACILITY DESCRIPTION:** This is a sea level static test cell with a test section measuring 23 feet wide by 22 feet high by 83 feet long. The facility is operated with an inlet bellmouth diameter currently available at 3 feet, although this is expandable as required for higher thrust levels. Atmospheric exhaust is employed through a stack at up to 843,000 CFM.

**ALTERNATE FACILITIES:** Five other similar engine test cells are available at Torrance Site B. An alternate facility is available (Torrance Site A) for engine components testing at a site approximately one mile from Torrance Site B. Air supplied to the test engine is available from: (1) Dry pressurized air from reciprocal compressors, (2) Refrigerated air from a turbo-expander and ejector system, and (3) Heated air from vitiated combustors. The Site A test cell dimensions for each of 5 test cells are 20 feet wide by 15 feet high by 30 feet in length.

**TESTING CAPABILITIES:** Complete engine testing is possible for turbojets (dry and w/afterburners), turbofans (dry and w/afterburners) and turbofans (w/duct burning). Engine dynamic simulation can be achieved either manually or automatically by variable geometry control, fuel control, or freestream variation. Flow visualization is accomplished utilizing streamline tracing dyes. Engine components and auxiliary systems testing capabilities are possible for afterburners, combustors, compressors, fuel control systems, exhaust nozzles, heat exchangers, inlets, and variable geometry control.

A Datatron Digital Data Acquisition System is utilized for the 6 test cells at Site B. This is divided into two subsystems, one with a 50 data channel capability (sampling rate: 1/sec), and the other with 300 channels of low level data, 10 frequency channels, 60 miscellaneous channels, and 550 pressure channels. Both systems are directly controlled by an IBM 1800 computer system which also provides on-line real time data reduction. Dynamic data recording capabilities include (3) CEC Model 133 36 channel oscilloscopes, (4) Beckman 8 channel pressurized ink recording systems, and (2) Honeywell Model 7600 14 channel tape recorders.

**OTHER SERVICES:** Hydraulic services are available for 40 gal/min at 4000 psia.

**FACILITY COST HISTORY**

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: COST \$ Not ESTIMATED REPLACEMENT VALUE \$ Available
CONTRACTOR:	
IMPROVEMENTS AND COSTS: Not Available	

**PLANS FOR FACILITY IMPROVEMENTS:** A five year master plan will soon be initiated to construct additional complete engine and components test facilities for the Los Angeles Division Laboratory.

SCHEMATIC

(Not Available)

FACILITY PERFORMANCE DATA

Facility Operating Envelope

(Not Available)

Total Temperature (°R): Ambient  
Total Pressure (psia): Ambient  
Mass Flow Rate (lb/sec): As required by engine  
Maximum Run Time: Continuous  
Maximum Engine Thrust  
Measuring Capability (lb<sub>f</sub>): 10,000  
Note: Thrust capability is expandable as required to 25,000 lb<sub>f</sub>.

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type ( <u>Hydrocarbons</u> )	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Heptane, JP-5	32,000 gallons	(Ambient; can deliver up to 65 psia)	Up to 4000	Ambient
JP-4	12,000 "	"	"	"
JP-5R	1,000 "	"	"	"
Aviation Gasoline	1,000 "	"	"	"

AIR FORCE AERO PROPULSION LABORATORY  
SEA LEVEL ENGINE TEST CELL NO. C

REPORTING INSTALLATION Air Force Aero Propulsion Laboratory Wright-Patterson Air Force Base Ohio 45433	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Technical Facilities Division
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: APMD Phone: (513) 255-4430

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This testing complex consists of two sea level static engine test stands (Nos. C and D). They are of "U" type design (vertical intake and exhaust stacks) and are equipped to accommodate turbojet engines in the 20,000 lb thrust class. Cell No. D is limited acoustically, but Cell No. C is fully operational. The test section dimensions for the two cells are identical at 45 feet wide by 51 feet high.

**ALTERNATE FACILITIES:** Five alternate sea level static test cells are available in the 10,000 lb thrust class. The cells cross section size is 20 by 20 feet and they are equipped to accommodate non-afterburning turbojet engines.

**TESTING CAPABILITIES:** Both test cells C and D are equipped with a minimum of instrumentation and control systems, since they are used primarily for repetitive long-term engine oil qualification tests. Engine component testing is possible for turbojet afterburners.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$1150	CONSTRUCTION YEAR: 1941 COST \$ 500K/cell ESTIMATED REPLACEMENT VALUE \$1572K/cell
CONTRACTOR: Unknown	LOCATION:
<b>IMPROVEMENTS AND COSTS:</b> Not Available	

PLANS FOR FACILITY IMPROVEMENTS: None

## **SCHEMATIC**

(Not Available)

#### **FACILITY PERFORMANCE DATA**

Total Temperature:	Ambient
Total Pressure:	Ambient
Mass Flow Rate:	As Required by Engine
Maximum Run Time:	Continuous
Maximum Altitude (feet):	Sea Level
Maximum Engine Thrust	
Measuring Capability (lb <sub>f</sub> ):	20,000

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbon (JP-4)	800,000 gallons		30,000	Ambient

AIR FORCE FLIGHT TEST CENTER  
HORIZONTAL THRUST STAND FACILITY

REPORTING INSTALLATION: Air Force Flight Test Center Weights and Thrust Section (PRTIW) Edwards, California 93523	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Flight Test Instrumentation Branch Weights and Thrust Section
OTHER SOURCES OF INFORMATION: (1) "AFFTC Test Facilities Handbook, Section V", FTC T1H-63-2003, Rev Jan. 1967, (2) "AF Tech Facility Capabilities Key", AFSCP 80-3, Sept. 1967	LOCAL OFFICE TO CONTACT FOR INFORMATION: Marion H. Yancey, Jr., Chief Weights and Thrust Section (PRTIW) Phone: (805) 277-3479

DESCRIPTION AND TESTING CAPABILITIES

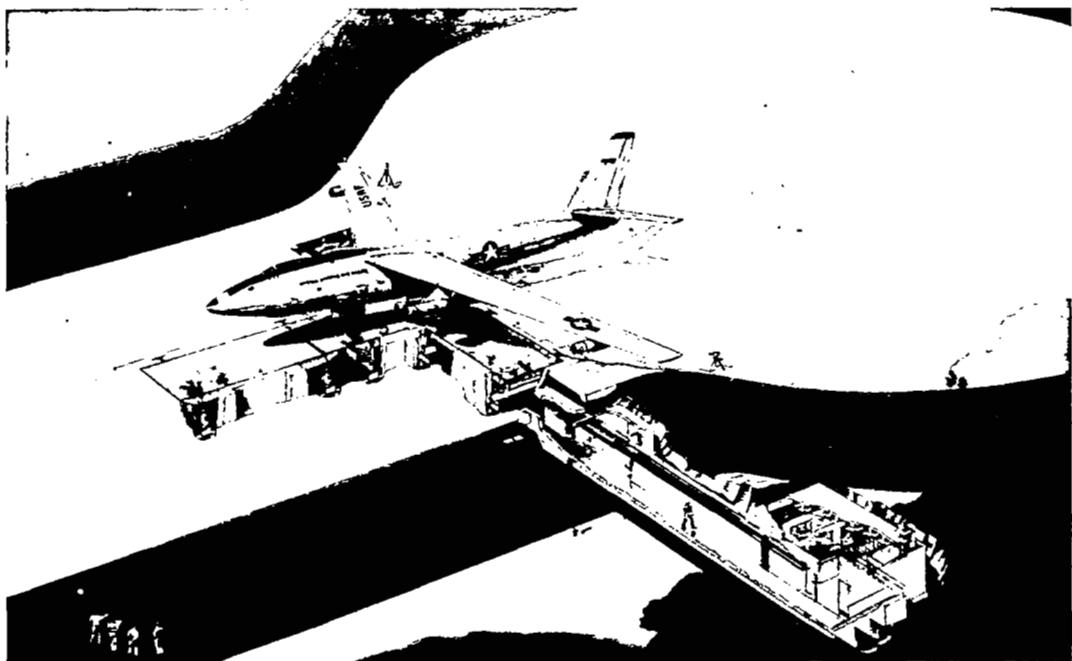
**FACILITY DESCRIPTION:** This facility is a sea level static test stand consisting of four flush mounted platforms installed in a cruciform pattern, each instrumented to measure and record 125,000 pounds forward or 60,000 pounds reverse thrust. Each platform can measure and record weight up to 300,000 pounds and weight-loss of 54,000 pounds during thrust calibrations. The platforms rest at each corner on strain gage type load cells which are incorporated in a flexure strap suspension system tied into the pit structure. Weight information is transmitted by these load cells when the platforms are placed under test aircraft loading. Two other load cell assemblies are attached to the front of each platform and associated pit structure by means of flexure rods. These load cell assemblies restrain the fore and aft movement of the platform. In addition, they transmit thrust information when the platforms are placed under aircraft thrust loads. Two tie rods, one located at the platform fore end and one at the aft end, provide lateral restraint. Location of the masses of both platforms and the test aircraft prevent platform overturning.

**TESTING CAPABILITIES:** This facility is a static thrust and weight measuring system. It is used to measure the thrust produced by a jet engine installed in an aircraft during ambient conditions. Test conditions such as ambient air temperature, barometric pressure, wind velocity, and direction are also measured to provide data to correct the test static thrust data to sea level standard conditions. Continuous strip chart recording equipment, located in an underground control room, is used to measure the thrust produced by the engines with the aircraft secured to the thrust platforms. Two television cameras, monitored in the control room, are used to view the operation of the aircraft engines or any of the aircraft accessories, such as flaps or air bleed doors, during thrust runs.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$450	CONSTRUCTION YEAR: 1958 COST \$1,040,000 * ESTIMATED REPLACEMENT VALUE \$ Unknown
CONTRACTOR: Bristol Engineering Corp.	LOCATION: Bristol, Pa.
IMPROVEMENTS AND COSTS: No significant improvements to date.	
<p><b>*Note:</b> Construction cost excludes land.</p> <p>PLANS FOR FACILITY IMPROVEMENTS: Not Available</p>	

## SCHEMATIC



#### **FACILITY PERFORMANCE DATA**

Total Temperature:	Ambient
Total Pressure:	Ambient
Mass Flow Rate:	Unlimited, as required by engine
Maximum Engine Thrust	
Measuring Capability (lb <sub>f</sub> ):	125,000 (forward) 60,000 (reverse)

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	On-board aircraft			

ALLISON SEA LEVEL TEST CELL NO. 1

REPORTING INSTALLATION: Allison, Division of General Motors P.O. Box 894 Indianapolis, Indiana 46206	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT:
OTHER SOURCES OF INFORMATION: Allison Brochure, "Research and Development Facilities", March 1968.	LOCAL OFFICE TO CONTACT FOR INFORMATION: J. S. Brody, Chief Test Engineer Phone: (317) 243-5155

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This sea level static test cell measures 18 feet in diameter and 48 feet long. Induced inlet air is mechanically and electrostatically filtered. The test cell, which is sound-treated, can also provide for high bypass ratio and engine exhaust conditions. The test cell as well as 5 other alternate sea level test cells also have provisions for an electrical and hydraulic accessory drive loading system, a Universal Test Fuel Control System for infinite fuel flow scheduling and instantaneous X-Y plotting of fuel flow and engine temperature versus engine speed, water-cooled exhaust, a quick change "stand wired mixer box" engine control system for flexibility in utilization of test cells, external engine lubrication systems, and engine mounting on dollies for rapid test cell installation and removal. Electrical interlocks are provided to prevent operation of the engine when under hazardous conditions thereby avoiding damage to the engine, test equipment, or test personnel. An automatic fire protection system utilizing hot air and vapor detection sensors, is available, with backup manual controls located at various remote locations.

ALTERNATE FACILITIES: Five other similar static sea level test cells of the same test section size are available. One test cell is equipped for vertical test of lift engines at ambient conditions. It measures vectored thrust up to 15,000 lb vertically, 4000 lb in one horizontal plane,  $\pm 15^\circ$  deflection exhaust, fuel flows to 30,000 lb/hr, and 280 lb/sec metered, induced airflow. The remaining four test cells can provide engine fuel flow to 30,000 lb/hr, reheat burner fuel flow to 48,000 lb/hr, measured thrust to 30,000 lb, and measured airflow to 250 lb/sec.

TESTING CAPABILITIES: Facility-installed instrumentation monitors test conditions and engine functions, and includes provision for automated recording as well as visual display. All test cells are connected with central data recording and analog computer facilities. These computer facilities are used for on-line data reduction or to provide a closed control loop during a development program.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: COST \$ ESTIMATED REPLACEMENT VALUE \$ Not Available
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	
PLANS FOR FACILITY IMPROVEMENTS: Not Available	

SCHEMATIC

(Not Available)

FACILITY PERFORMANCE DATA

Total Temperature: Ambient  
Total Pressure: Ambient  
Mass Flow Rate, Induced (lb/sec): 420  
Maximum Run Time: Continuous  
Maximum Engine Thrust Measuring Capability (lb<sub>f</sub>): 40,000

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons			35,000 48,000 (reheat burner fuel flow)	

AVCO LYCOMING AMBIENT TEST CELL T-14 AND  
TEMPERED AIR TEST CELL D-4

REPORTING INSTALLATION: AVCO Lycoming Division 550 S. Main Street Stratford, Connecticut 06497	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Test Facilities Engineering
OTHER SOURCES OF INFORMATION: AVCO Lycoming Brochure, "Facilities for Research and Development at AVCO Lycoming Division", April 1970	LOCAL OFFICE TO CONTACT FOR INFORMATION: John Hart, Manager Test Facilities Engineering Phone: (203) 378-8211, ext 785

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION (TEST CELL T-14):** This is a special purpose sea level static test cell of the open circuit U-type configuration with test section dimensions measuring 14 ft by 14 ft by 60 ft in length. The cell is designed for heavily instrumented gas producing engines such as turboprops or turbofans. A water-brake absorption dynamometer is available for power absorption of turboprop and turboshaft engines and a thrust bed is installed for general endurance testing of turbojet and turbofan engines.

**ALTERNATE AMBIENT FACILITIES:** Eight other static sea level test cells are available. Test cells F-1 and F-2 are used for turboprop or turbofan development; these two cells have circular cross-section test sections (18 ft in diam) with the engine mounted on the cell centerline. Both cells are 120 ft long. There are two outdoor test stands: One cell, the Variable Attitude Test Stand, is used primarily for turboshaft and turboprop testing. Engine pitch can be varied between 105° nose up and 90° nose down attitude. The second cell, the Outdoor Test Stand, is an all purpose test stand used for testing turboshaft, turboprop, and turbojet engines, with provisions for natural gas fuel. The four remaining test cells (D1F, D1R, D2F, and D2R) are of the open circuit U-type configuration with test section dimensions measuring 18 ft high by 16 ft wide by 19 ft in length. Two of these cells are equipped with low speed eddy current dynamometers in addition to water-brake systems for conducting calibration on turbo prop and turboshaft engines up to 2000 SHP at 3000 rpm. All four cells are equipped with apparatus for conducting sand and dust ingestion test programs.

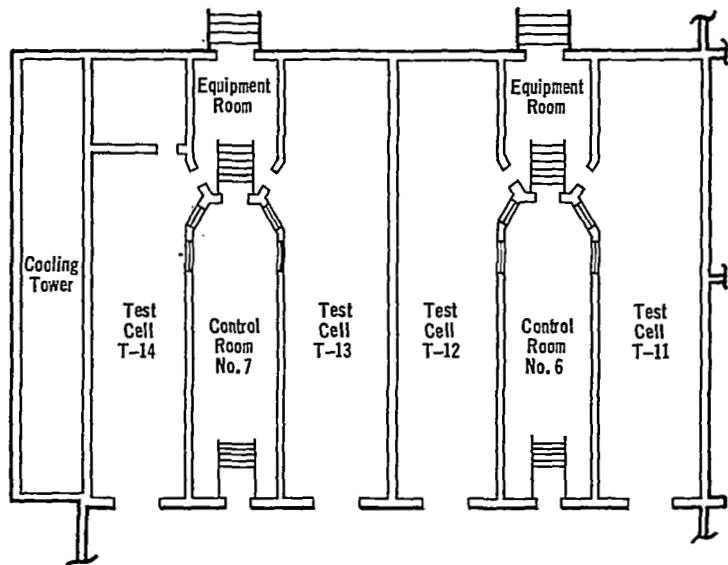
**FACILITY DESCRIPTION:** Nine test cells are available for full scale engine testing which are capable, in addition to ambient operation, of ram and/or tempered air delivery. Seven test cells are equipped for delivery of 28 lb/sec tempered air at a temperature range of 60 to 130°F with a ram pressure ratio of 1.35. Four of these cells (D-4, D-5, D-6, and D-7) have test section dimensions measuring 14 ft by 14 ft by 60 ft long. Two test cells (D-3 and D-8) are fully insulated test cells utilized for cold soak tests as well as other tests requiring refrigerated air. A refrigeration plant delivers 30 lb/sec air flow at temperatures down to -65°F supplying air to these cells. Test Cell D-3 measuring 18 ft wide by 7 ft high by 8 ft long contains a natural gas fuel supply. Test cell D-8 has test section dimensions 14 ft wide by 12 ft high by 24 ft long.

**TESTING CAPABILITIES:** There are a total of 16 test cells and 2 outdoor test sites available for sea level full scale engine testing of turboshaft, turboprop, turbojet, and turbofan type engines. The test cells are of the open circuit U-type configuration and can operate in excess of 200 lb/sec ambient air flow. A water-brake absorption dynamometer system is available in each cell and outdoor test site. On-line data acquisition and computation is available utilizing an IBM 1800 computer. The output can be displayed on a TV monitor for up to 24 parameters. The full output can be made on a line printer or magnetic tape for off line processing. The system contains the potential for closed loop operations for sustained endurance operation. The following channels are available in each cell: 72 Air pressures, 9 Differential air pressures, 3 Fluid flows, 40 Hydraulic pressures, 3 Positions (360°), 62 Temperatures, 2 Torque values, 3 Speeds, and 4 Vibrations. Additional channels can be made available from adjacent cells for special tests through use of a switchover network.

FACILITY COST HISTORY \*

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: COST \$ Not Available* ESTIMATED REPLACEMENT VALUE \$7,600,000
CONTRACTOR:	LOCATION:
<b>IMPROVEMENTS AND COSTS:</b> All test cells except four (D-3, D-8, F-1, and F-2) have been completely rearranged and modernized within the past three years at a total cost of \$1,500,000.	
* Note above: Includes cost for 16 engine test cells and 2 outdoor test sites.	
PLANS FOR FACILITY IMPROVEMENTS: Not Available	

SCHEMATIC



FACILITY PERFORMANCE DATA

Total Temperature (°R): 520 to 590  
 Total Pressure: Ambient + Ram @ 1.35  
 Pressure Ratio  
 Mass Flow Rate (lb/sec): 200 + (Induced)  
 28 (Tempered)  
 Maximum Run Time: Continuous  
 Maximum Engine Thrust  
 Measuring Capability (lbf): 10,000  
 Maximum Engine Power  
 Level (SHP): 10,000+

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Delivery Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons (JP-4 & -5)	160,000 gal	40	11,250	50 to 120
CITE	30,000 gal	40	11,250	50 to 120
Diesel	23,000 gal	40	11,250	50 to 120
Natural Gas	Continuous	190	500,000 Btu/min	70 to 350

BOEING BOARDMAN ENGINE TEST SITE  
(Boardman, Oregon)

REPORTING INSTALLATION: The Boeing Company Commercial Airplane Group Box 3707 Seattle, Washington 98124	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT:
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mechanical Engineering Laboratories A. J. Daniels, Eng. and Oper. Div. Phone: (206) 655-1970

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This facility consists of three static sea level engine test stands (B-1, B-2, and B-3) centrally positioned on a site which is nominally 12.5 miles by 12.5 miles and consists of 99,000 acres. Two of the three test stands (B-1 and B-3) have specially prepared surface acoustic fields, one being a flat crushed rock surfaced, 200 feet radius, 170° circular sector and the other (B-2) a flat concrete surfaced 250 feet radius, 80° circular sector. The B-1 test stand has two parallel horizontal steel beams at ground level, spaced so that a variety of existing interchangeable engine stands can be positioned for various types of tests. Existing engine stands are for JT3D, JT8D, J75 and J93 engines. The B-2 test stand is a reinforced concrete pad with two parallel steel beams 60 feet long imbedded in the surface and special provisions for A-frame, X-frame, and cantilever type engine mounts, which can be easily interchanged. Alongside and aft of the engine mount pad is a poured concrete terminal building which houses an engine operator's console, signal conditioning equipment, and data acquisition equipment for dynamic measurements. Four hundred channels of centralized data acquisition equipment and alternate engine controls are housed in the main block house approximately 800 feet away. The B-3 test stand is an X-frame overhead stand with a force balance system. The suspension system is interchangeable for either JT3D, JT8D, or J75 engines.

**TESTING CAPABILITIES:** This facility is used primarily for exploratory and development testing involving high noise level operations and is considered the long range site for any future high noise level or long duration engine tests. Applicable engine types include turbojets and turbofans, dry and w/after-burners; and turbofans w/duct burning. Applicable component or auxiliary systems testing capabilities include air inlets, exhaust nozzles, suppressors, thrust augmentors, thrust reversers, and complete nacelles. The data acquisition system, which is common to all three test stands has capability for 192 sub-computed pressures and 196 other individual measurements. Sampling rates range from 12 to 20 samples/sec. Only quick-look data are available on-site. Paper punch tapes are sent to Seattle for processing for final computer processed data.

**OTHER SERVICES:** Auxiliary air (portable power units) for engine starting; Service air, 1 lb/sec at 150 psia.

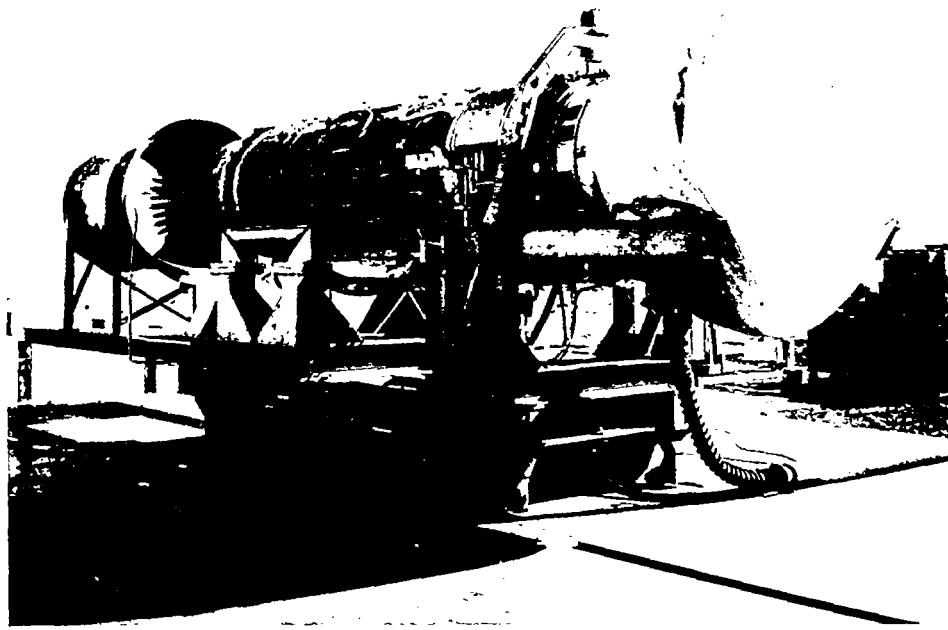
\* Note Below: Costs are for 3 test stands, B-1, B-2, and B-3, together with common support equipment.  
\*\* Note Below: B-1: \$92K, B-2: \$94K, B-3: \$74K, Instrumentation and Control House: \$295K.

FACILITY COST HISTORY \*

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1967-69 (Jan. 70) ESTIMATED REPLACEMENT VALUE \$905,000	COST \$555,000 **
CONTRACTOR: The Boeing Co.	LOCATION: Seattle, Washington	
IMPROVEMENTS AND COSTS: (1969) New pad, control and terminal building, Cost \$222,000.		

**PLANS FOR FACILITY IMPROVEMENTS:** (a) B-1 and B-2 new 100,000 lb thrust cantilever stands with 180° acoustic field and engine centerline heights to 16 ft are planned; (b) New building for engine buildup and support work plus on site operations office space; (c) New Boardman Test Site (No. 2) will be added to accommodate additional engine test capabilities, i.e., endurance, sonic fatigue, etc.

SCHEMATIC  
B-2 STAND WITH J-93 ENGINE



FACILITY PERFORMANCE DATA

Total Temperature: Ambient  
Total Pressure: Ambient  
Mass Flow Rate: Unlimited, as required by engine  
Maximum Run Time: Continuous  
Maximum Engine Thrust  
Measuring Capability ( $lb_f$ ): 25,000 (B-1 & B-3)  
100,000 (B-2)

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery ( $lb_m$ /hr)	Temperature Range (°F)
Hydrocarbons (B-1 & B-3)	30,000 gallons	Ambient	20K @ 10 psig	Ambient
Hydrocarbons (B-2)	20,000 gallons	Ambient	24.1K & 120K	Ambient

BOEING TULALIP ENGINE TEST SITE  
(Marysville, Washington)

REPORTING INSTALLATION: The Boeing Company Commercial Airplane Group Box 3707 Seattle, Washington 98124	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT:
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mechanical Engineering Laboratories A. J. Daniels, Eng. and Oper. Div. Phone: (206) 655-1970

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility consists of two static sea level engine test stands (T-1 and T-2) located in a 350 acre cleared area at about the geometric center of the site. The area provides a 200 feet radius, 170° crushed rock surface acoustic test arena on one side of each test stand. The T-1 test stand is capable of handling engines of up to 100,000 lbf with engine centerline heights of up to 16 feet. The stand is of a cantilever design. This design was used to keep one side of the engine free from structure which could influence far field acoustic data. The T-2 test stand is an X-frame design suitable for engines with thrust up to 75,000 lbf.

TESTING CAPABILITIES: Either test stand is ideally suited to airbreathing propulsion system testing which requires evaluation of engine performance, inlet or exhaust duct losses, engine accessory performance, power plant temperature environments or acoustic environments. Currently the facilities are being used to develop a quieter JT9D/747 high performance nacelle.

Engine components and auxiliary systems testing capabilities include afterburners, exhaust nozzles and inlets for such engines as turbojets, dry and w/afterburners; turbofans, dry; and turbofans, afterburners and w/duct burning (the last two being limited by community noise).

The two test stands share a Beckman 210, 200 channel, 5000 sample/sec engine data acquisition system. This data system outputs to magnetic tape, punched paper tape and to a PDP-8 computer, thus allowing a wide variety of data manipulations "on-line" as well as "off-line". An Ampex dynamic data recording system is available. In addition, the existing acoustic data system typically allows acquisition of acoustic data from up to 36 microphones located at either test stand.

OTHER SERVICES: Auxiliary air is available at 2.7 lb/sec at 250 psia from a 600 CF accumulator; Service air, at 150 psia; and a complete on-site shop facility.

\* Note Below: Costs are for two test stands, T-1 and T-2, together with common support equipment.

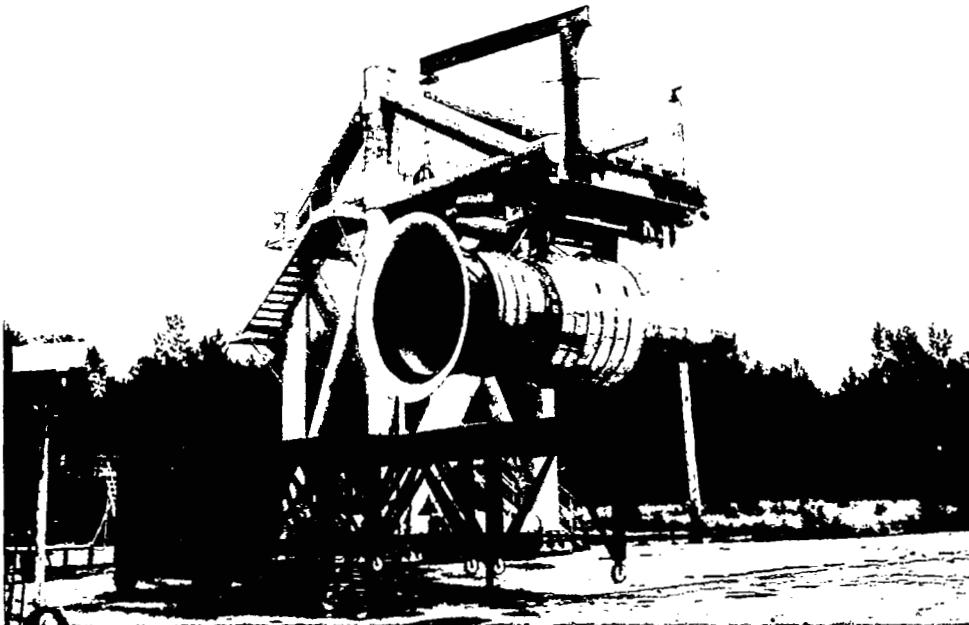
\*\* Note Below: T-1: \$454,000, T-2: \$200,000, Instrumentation: \$392,000.

FACILITY COST HISTORY \*

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1967-69 (Jan. '70) ESTIMATED REPLACEMENT VALUE \$1,150,000	COST \$1,046,000 **
CONTRACTOR: The Boeing Company	LOCATION: Seattle, Washington	
IMPROVEMENTS AND COSTS: Note: These costs are part of construction cost above; (1969) Auxiliary air system, Cost \$85,000; (1969) New T-1 100,000 lbf thrust cantilever stand, Cost \$369,000.		

PLANS FOR FACILITY IMPROVEMENTS: Considerations for future growth needs include local test cells and additional test capability at the Boardman remote site.

SCHEMATIC  
**T-1 STAND WITH JT-9D ENGINE**



**FACILITY PERFORMANCE DATA**

Total Temperature:	Ambient
Total Pressure:	Ambient
Mass Flow Rate:	Unlimited, as required by engine
Maximum Run Time:	Continuous
Maximum Engine Thrust	
Measuring Capability (lb <sub>f</sub> ):	50,000 (T-1)
(Current Installation)	50,000 (T-2)

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	40,000 gallons	Ambient	18,000	Ambient

BOEING TURBOJET/TURBOFAN ENGINE TEST STAND  
(Wichita, Kansas)

REPORTING INSTALLATION: The Boeing Company Wichita Division 3801 South Oliver Wichita, Kansas 67210	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: Power Plant Laboratories W. K. Hayenga
OTHER SOURCES OF INFORMATION: Boeing Brochure, "Engineering Laboratory Facilities", Wichita Division, D3-4608-5, November 1968	LOCAL OFFICE TO CONTACT FOR INFORMATION: R. D. Scherer Facilities Manager Phone: (316) 687-4904

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is a sea level static engine test stand consisting of a steel "H" frame type structure designed to hang one of two turbojet or turbofan engines. The space between the uprights measures 19 ft, 2 inches, in width and 14 ft, 9 inches, from the concrete base surface to the bottom of the overhead horizontal support beams. When thrust measurement is required a flexure section is used, resulting in a 12 ft, 1 inch, vertical distance between the concrete base surface and the bottom of flexure section. Thrust capacity of the stand is rated at 50,000 lb and could easily be upgraded by modification to 75,000 lbf.

TESTING CAPABILITIES: This facility has been used for performance testing of J57 and TF33 engines. Related programs for which the stand has been used include the following: (1) Sound suppressor development and qualification, (2) Inlet development, (3) Cowling and fan duct performance, (4) Pressure and temperature surveys in all engine compartment cavities, (5) Fuel additive and fuel heater development tests, and (6) Anti-icing system development and qualification tests.

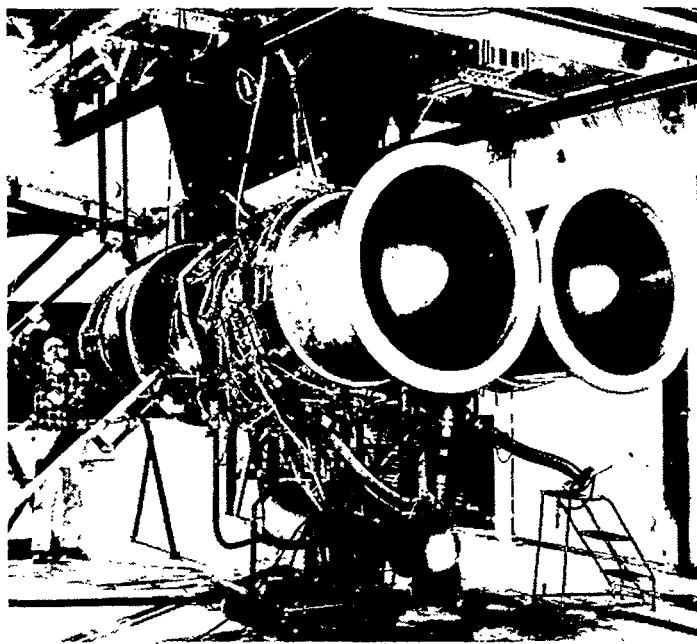
The stand is served by a 10 ft x 15 ft sound treated control house and a 5000 gallon fuel tank with a centrifugal pump for boosting pressure into the engine driven fuel pump. Available for use at this test stand is an automatic data sampler and recorder system with computer compatibility. Approximately 200 channels of pressure, temperature, force, displacement and velocity type parameters may be recorded. On site "quick-look" data in the form of tabular listing is available. Final form computer processed data may be obtained in less than one day turnaround time.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1955-61 COST \$25,000 ESTIMATED REPLACEMENT VALUE \$ Not Available
CONTRACTOR:	LOCATION:
IMPROVEMENTS & COSTS:	

PLANS FOR FACILITY IMPROVEMENTS: None.

SCHEMATIC



FACILITY PERFORMANCE DATA

Total Temperature: Ambient

Total Pressure: Ambient

Mass Flow Rate: Unlimited, as required by engine

Maximum Run Time: Continuous

Maximum Engine Thrust  
Measuring Capability (lbf): 30,000  $\pm$  .5%

Note: Thrust capacity is 50,000 lbf with potential of 70,000 lbf (through modification)

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	5000 gallons			

CURTISS-WRIGHT SEA LEVEL TEST CELL NO. WX38

REPORTING INSTALLATION: Curtiss-Wright Corporation One Passaic Street Woodridge, New Jersey 07075	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Experimental Test Equipment and Facilities
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Experimental Test Equipment and Facilities Phone: (201) 777-2900

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This is a static sea level turbojet engine test cell in which primary and secondary air is drawn from the atmosphere through sound attenuated inlets and discharged to atmosphere by means of jet ejector action and natural convection through steel lined concrete exhaust stacks. The test cell dimensions are 30 by 30 by 90 feet. An extensive sound treatment system at the inlet and outlet ends of the test cell efficiently muffles engine and exhaust noises during 24 hour operation. The large effective flow area through the test cell and its sound treatment provides engine operation under essentially "true atmosphere" conditions, so that test performance is not distorted by a low pressure or high ambient velocity test environment. Water sprays incorporating temperature controlled flow regulation, are used to cool exhaust gases before contact with the sound treatment.

**ALTERNATE FACILITIES:** Two alternate test cells (Nos. WX49 and WX50) are available with similar capabilities to the subject test cell. Additional test cells of the same type are also available with 10K and 20K lbf engine thrust measuring capability.

**TESTING CAPABILITIES:** This facility can be used for a variety of tests, including engine endurance and engine dynamic simulation (with control provided by engine variable geometry or engine fuel control). Components such as afterburners, fuel control systems, and exhaust nozzles have been tested for the following engine types: turbojets (dry and w/afterburner), turbofans (dry), and turboramjets.

Smooth approach measuring nozzles, designed to ASME standards, are flexibly attached to the compressor inlet to provide airflow measurement. The control room is well equipped with modern instrumentation, and is arranged to provide excellent observation and control of test engines by a minimum number of test personnel. All electrical instrumentation is supplied from a special constant voltage source. Precision indicators are used for measuring all test data. Many special instruments provide such functions as electronic throttle control, ice detection, and exhaust nozzle area indication. The test cell features a warning system with 26 circuits that gives visual and audible alarm of operating malfunctions. Fire protection is provided by cell flood and localized spurt Cardox systems, supplied from a central storage source.

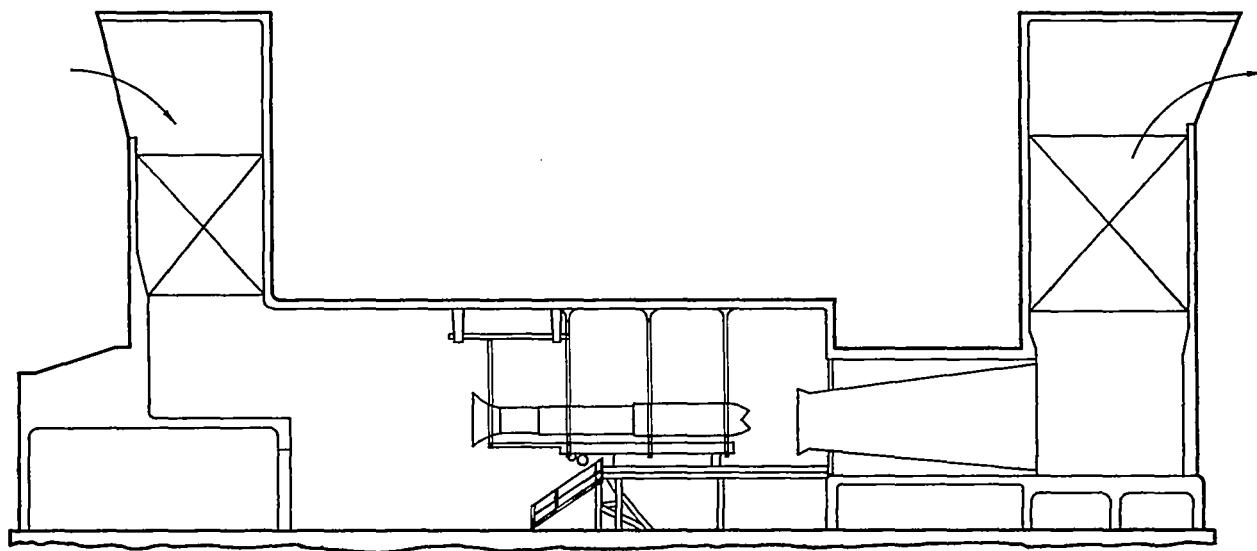
A H-P Dymec Punch Paper-tape data acquisition system is available, with 200 data channels. Dynamic data recording is provided by an Ampex FRL200 magnetic tape system with 42 data channels.

**OTHER SERVICES:** Auxiliary air is available for 150 lb/hr at 80 to 600 psia; 1500 psi air, is available from storage tanks; and portable hydraulic supply systems, 25 gal/min at 3000 psi.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$200/500 plus test services	CONSTRUCTION YEAR: 1943-44 COST \$ 500,000 (est) ESTIMATED REPLACEMENT VALUE \$1,700,000
CONTRACTOR: Mahoney-Troast & G. A. Fuller IMPROVEMENTS AND COSTS: (1952-53) Modifications for 20,000 lb Turbojet Use, Cost \$550,000; (1954-56) Modifications for 50,000 lb Turbojet/Turboramjet Use, Cost \$300,000.	LOCATION: New York/New Jersey Metropolitan Area Offices
PLANS FOR FACILITY IMPROVEMENTS: None	

SCHEMATIC



FACILITY PERFORMANCE DATA

Mass Flow Rate  
 Primary (lb/sec): 300 (Induced)  
  
 Mass Flow Rate  
 Secondary (lb/sec): 900 (Induced)  
  
 Maximum Run Time: Continuous  
  
 Total Pressure (psia): Ambient  
  
 Maximum Altitude (feet): Sea Level  
  
 Maximum Engine Thrust  
 Measuring Capability (lb<sub>f</sub>): 50,000

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	400,000 gallons	65.	250,000 (engine) 50,000 (after-burner)	Ambient

## GENERAL DYNAMICS/CONVAIR SEA LEVEL ENGINE TEST CELLS NOS. 4 &amp; 5

REPORTING INSTALLATION: General Dynamics/Convair Division P.O. Box 1950 San Diego, California 92112	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: Engineering Test Facilities Department 578-0
OTHER SOURCES OF INFORMATION: (1) GD/Convair, "Thermodynamics Laboratory Report No. RT-309. (2) GD, "Thermodynamics Laboratory Report No. RTL-8-191.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Not Available

## DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This facility consists of two sea level static test cells (Nos. 4 & 5) housed in a large hangar silencer. The hangar silencer is an engine noise suppressor, designed to accommodate two turbojet afterburning engines of the 30,000 pound thrust class not operating simultaneously. The facility has the growth potential to accommodate two engines of 50,000 pound thrust not operating simultaneously. The facility is acoustically treated to dissipate the sound energies of the primary air, secondary cooling air, and exhaust gases. An operational control room adjoins the hangar on the east side and contains individual controls for the operation of the two test stands.

Cooling air is pumped by the ejector action of a first and second stage augmentor arrangement. The second stage augmentor serves as a mixing section in the cooling air ejector system. The ejectors were designed to pump cooling air at a flow ratio of 2:1, secondary to primary airflows. All design airflow accommodations are based on 275 lbs per sec of primary airflow. Provisions have been made to allow increased primary airflows in order to satisfy future engine requirements. Water is injected into the exhaust stream in the second stage augmentors and serves as a control agent in regulating the exhaust gas temperatures. The control is normally operated at a command signal (set point) corresponding to 450°F exhaust stream temperature. The exhaust section of the silencer is the most critical area during an engine operation, since it is subjected to the total energies of the exhaust gases. A steel grid has been placed inside the exhaust area to dissipate some of the velocity energy of the gases prior to their entry into the soundstream.

**TESTING CAPABILITIES:** Test Cell No. 5 is specifically adapted to the operations of a bare engine test stand while Test Cell No. 4 is suited for the operations of a fuselage test stand. The design thrust capacity of each stand is 30,000 pounds horizontally and this is reacted into the floor through steep pads. Each test cell is furnished with fuel, air, and water supply outlets. Pressure regulators are installed in the fuel and air systems in the proximity of the test cell areas. These serve to regulate the pressures to meet the specific requirements of the engine. Provisions have been made for the addition of a second fuel system, should future operations demand it. Routing facilities have been installed for instrument and electrical transmission lines between the test areas and the control room.

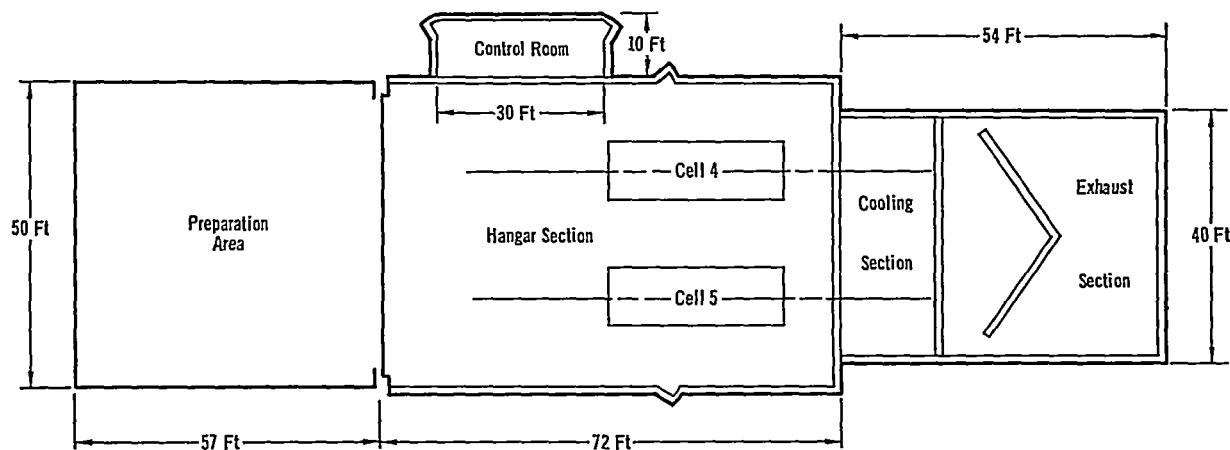
\*Note below: Eight-hour shift is for typical 8-man crew consisting of 3 engineers and 5 mechanics. Costs for test preparation and reports are dependent on the specific project, and a figure of about \$20/manhour should be used for estimating purposes.

## FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Approx. \$1080*	CONSTRUCTION YEAR: COST \$300 (est)
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None at this time.

SCHEMATIC



FACILITY PERFORMANCE DATA

Total Temperature: Ambient  
 Total Pressure: Ambient  
 Mass Flow Rate (lb/sec): 275 (Induced)  
 Maximum Run Time: Continuous, but limited to 8 minutes at maximum exhaust temperature and thrust condition  
 Maximum Engine Thrust  
 Measuring Capability (lb<sub>f</sub>): 30,000  
 50,000 (Growth potential)

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons or Aviation gasoline	22,500 gal	Ambient	400 gal/min @ 150 psi	Ambient

GENERAL DYNAMICS/FORT WORTH PROPULSION SYSTEMS TEST STAND

REPORTING INSTALLATION: General Dynamics/Fort Worth Division P.O. Box 748 Fort Worth, Texas 76101	STATUS OF FACILITY: ACTIVE COGNIZANT ORGANIZATIONAL COMPONENT: Engineering Test Laboratories
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION Manager, Engineering Test Laboratories Phone: (817) 732-4811

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** The test stand consists of a central control room with two sea level static test cells. The test cells are 20 feet wide by 32 feet high. Windows permit observation of operations in each cell. The semi-open cell utilizes a blast deflector and engine operations are usually limited to short time durations due to noise. However, two J-79 engines have been operated simultaneously in this cell. The enclosed (North) cell is acoustically insulated and utilizes water spray bars and diffusers to exhaust vertically to atmosphere. This cell contains a 7.5 ton movable crane hoist. J-79 and TF-30 type engines have been operated in this cell. The test stand fuel system consists of two 5,000 gallon underground tanks, and two pumps, each rated at 40,110 lb/hr at 194 feet head.

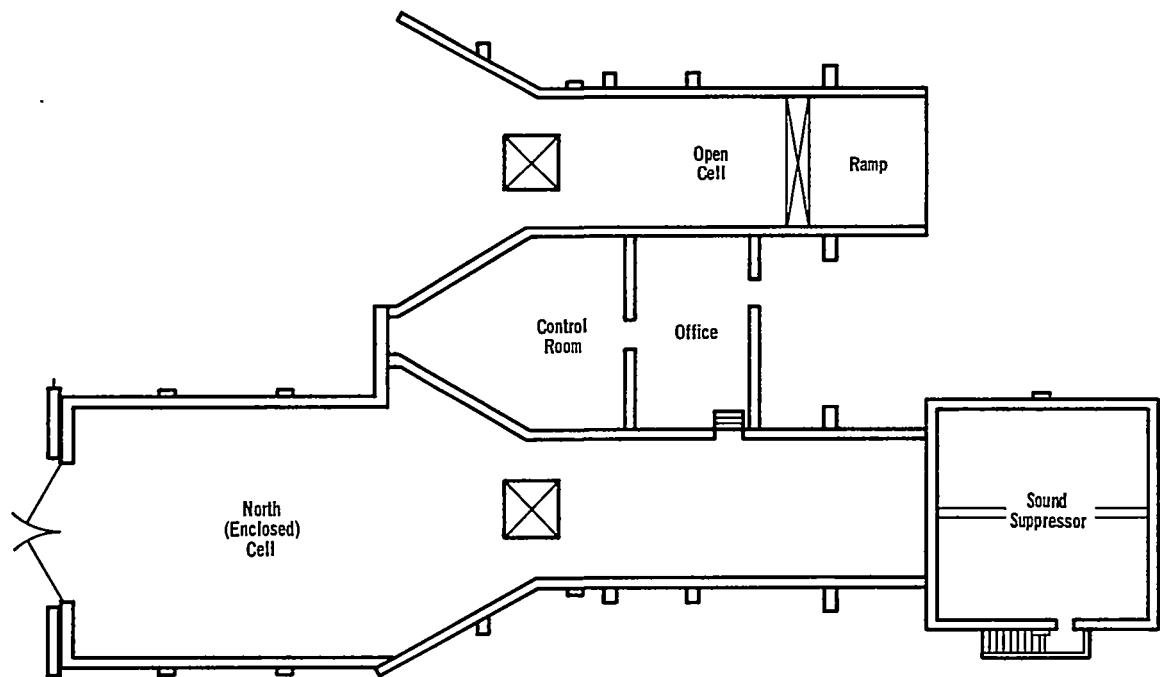
**TESTING CAPABILITIES:** Testing is possible for such engine types as turbojets (dry and w/afterburner) and turbofans (dry and w/afterburner). Space exists for a data system consisting of a Magnetic Tape Data Acquisition System, Flow System, "Quick Look" Monitoring System, Photo Panels, Manometer Boards, and a Temperature Recording System. The tape system can provide capabilities for monitoring and recording data on 150 continuous data items, 180 items on a time sharing basis and 20 acoustic items either continuous or time sharing. Standard and/or special laboratory equipment is employed as required.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$1000/\$1500	CONSTRUCTION YEAR: 1952 COST \$100K(est) ESTIMATED REPLACEMENT VALUE \$850,000
CONTRACTOR: General Dynamics and Subcontractors	LOCATION: Fort Worth, Texas
IMPROVEMENTS AND COSTS: (1955) North cell sound suppressor, Cost \$325,000.	

PLANS FOR FACILITY IMPROVEMENTS: As required for prime contracts.

SCHEMATIC



FACILITY PERFORMANCE DATA

Total Temperature:	Ambient
Total Pressure:	Ambient
Mass Flow Rate:	Unlimited, as Required by Engine
Maximum Run Time:	Continuous
Maximum Engine Thrust Measuring Capability (lb <sub>f</sub> ):	20,000

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	10,000 gallons	Ambient	80,220 @ 194 Feet Head	Ambient

GENERAL ELECTRIC ACOUSTIC FACILITY (SITE IV-D)

REPORTING INSTALLATION: General Electric Company Aircraft Engine Group Peebles, Ohio	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Test Facilities Engineering Evendale, Ohio
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Phone: (513) 243-4964, Evendale, Ohio Phone: (617) 594-3872, Lynn, Massachusetts

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is located near the "crosswind facility", which is described in this report and shares the same control room, services and instrumentation. The terrain at this location is level and free of obstructions for 300 feet. The control room shared with the other Site IV test pads is located in the center of the site, and provides temperature, pressure, fuel flow, thrust and vibration instrumentation and controls for engine operation and monitoring. The engine in this facility is mounted in an overhead, cantilever type structure, which fully exposes one side of the test engine to sound recording equipment.

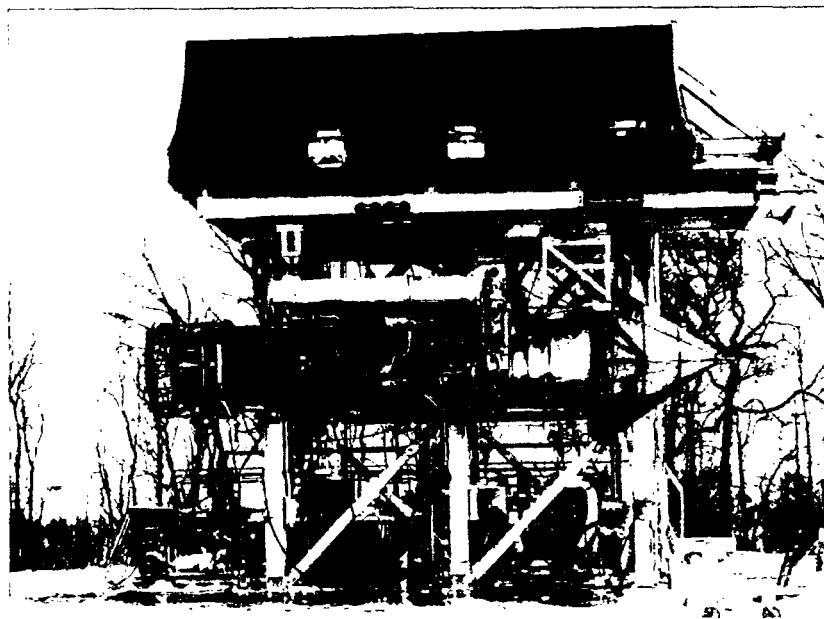
TESTING CAPABILITIES: Sound measuring equipment is available for measuring sound levels and frequencies within a 180° arc about the engine at all temperatures and pressures. Measuring equipment is also available for determining temperature and velocity profiles of the engine exhaust. The data system can handle 176 pressures, 292 temperatures, 1 thrust, and 8 frequencies (fuel flow and speed) which are recorded on digital data punch paper tape which can be processed on Evendale time share computers for conversion to engineering units for performance data calculations. Auxiliary services include: Air Supply (125 psi at 16 lb/sec), Electrical Supply (440 volts, 3 phase, 60 Hz, 110 volts, 400 Hz, 28 volts dc), and Water Supply (76 gpm at 100 psi). The Thrust Frame is capable of handling 100,000 lbs of thrust.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1968 COST \$ Not Available ESTIMATED REPLACEMENT VALUE \$ LOCATION:
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: Not Available

SCHMATIC



FACILITY PERFORMANCE DATA

Total Temperature	Ambient
Total Pressure:	Ambient
Mass Flow Rate:	As required by engine
Maximum Run Time:	Continuous
Maximum Altitude (ft):	Sea Level
Maximum Engine Thrust (lb <sub>f</sub> ):	100,000

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (gpm)	Temperature Range (°F)
Not Available		85	250	

GE CROSSWIND & ANTI-ICING FACILITY  
(Site IV-A; Peebles, Ohio)

REPORTING INSTALLATION: General Electric Company Cincinnati, Ohio 44135	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Test Facilities Engineering Evendale, Ohio
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Test Facilities Engineering Phone: (513) 243-4964

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an outdoor facility consisting of a bridge type structure supporting a turntable with a thrust frame for overhead engine mounting. The facility can test engines under cross-winds up to 100 knots at angles between 0-135°. The facility includes a wind tunnel, engine turntable, engine mounting equipment, etc. Thirteen 200,000 cfm two-stage axial-flow variable pitch fans driven by 200 hp electric motors provide the crosswind velocities.

The anti-icing facility utilizes the crosswind facility and air supply. Checkout and adjustment of icing systems can be made before engine installation, permitting testing to commence immediately after engine setup. The facility is capable of producing inlet icing conditions between one and three grains of ice per cubic meter at 23°F, depending on ambient conditions. Equipment includes engine inlet duct, water manifolds, spray nozzles, humidity measuring equipment, high speed cameras, and ice sampling equipment.

TESTING CAPABILITIES: The control room shared with the other Site IV test pads is located in the center of the site, and provides controls, temperature, pressure, fuel flow, thrust and vibration instrumentation for engine operation and monitoring. In addition, 352 pressures, 400 temperatures, 8 frequencies (fuel flow and speeds) and 1 thrust signal are recorded on a digital data punch paper tape which can be processed on Evendale time share computers for conversion to engineering units for performance data calculations.

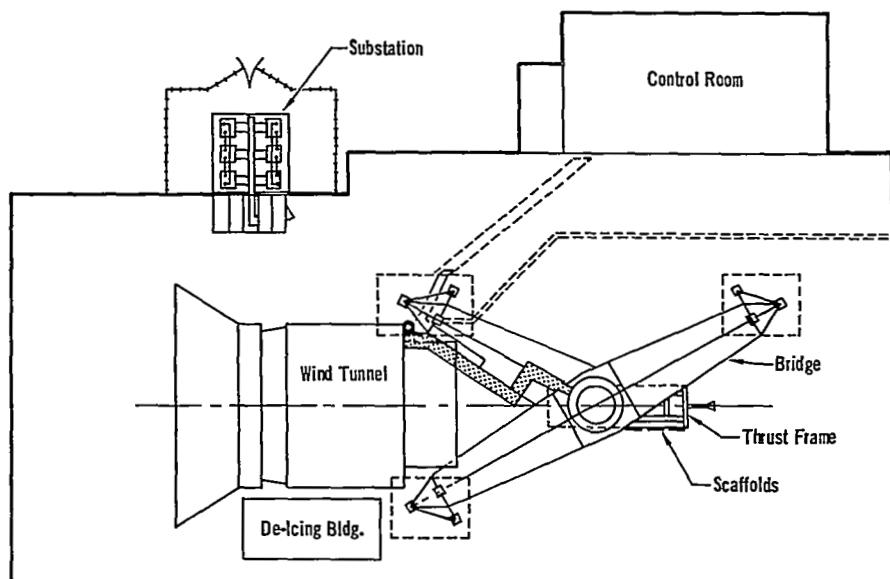
OTHER SERVICES: Compressed air is provided at 125 psi and at 16 lb/sec max. flow rate; Water, 75 gal/min at 100 psi; Electrical power, 440V, 3 phase, 60 Hz; 110V, 400 Hz; 110V, 60 Hz; 28 Vdc.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1965 COST \$ * ESTIMATED REPLACEMENT VALUE \$ Not Available
CONTRACTOR:	
IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: None

## SCHEMATIC



## FACILITY PERFORMANCE DATA

Total Temperature:	Ambient
Total Pressure:	Ambient
Mass Flow Rate:	Unlimited, as required by engine
Run Time:	Continuous
Maximum Engine Thrust	
Measuring Capability (lbf):	100,000 (Thrust frame capacity)

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	300,000 gal	Delivery (0 to 100)	185,000	Ambient

GE ENDURANCE TEST STAND  
(Site V; Pebbles, Ohio)

REPORTING INSTALLATION: General Electric Company Cincinnati, Ohio	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Test Facilities Engineering Evendale, Ohio
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION Test Facilities Engineering Phone: (513) 243-4964

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: Site V is a dual pad outdoor test facility which includes a two story control building with an equipment and service room on the main floor and an operating control room on the second floor. Two engine support structures with thrust frames and mounting hardware are provided on either side of the common control building for overhead mounting of two engines independently. Fuel, air, water and electrical services are available at either pad.

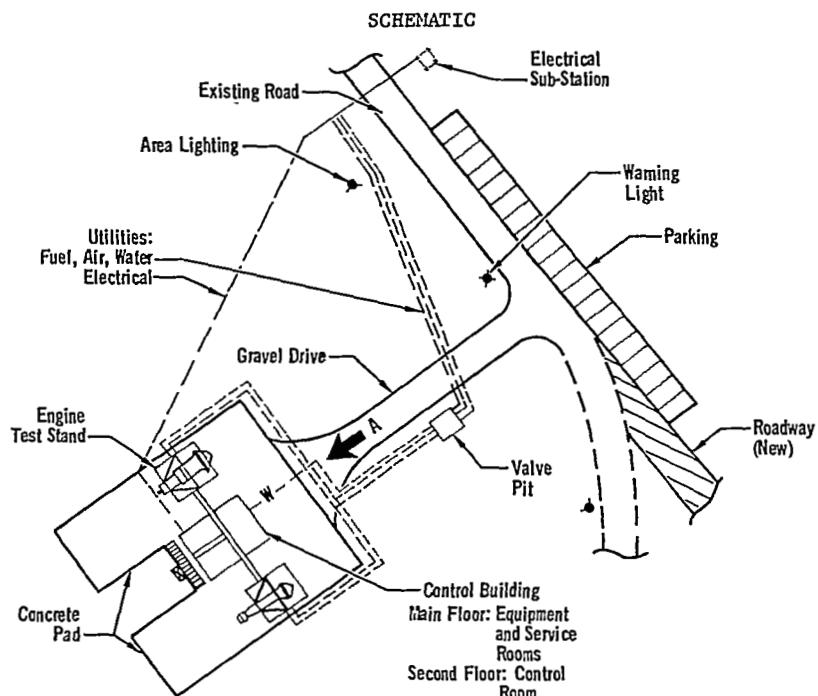
TESTING CAPABILITIES: Thrust reverser, infrared signature, and other types of testing which cannot be accomplished in fully enclosed test cells are possible at this site, in addition to endurance testing and systems mechanical performance tests. The tests are conducted from a common control room equipped with controls and display instrumentation for operation and monitoring of the engine. Console instrumentation for each pad consists of 12 vibration inputs, 48 temperatures, 22 pressures, 2 speed channels, fuel flow, thrust readout, etc. In addition, a digital data system provides up to 500 channels shared by the pads. Digital instrumentation capabilities at each pad include 100 temperatures, 88 pressures, 5 frequencies (fuel flow and speeds), and 1 thrust signal. The signals are recorded on a digital data punch paper tape which can be processed on Evendale time shared computers for conversion to engineering units for performance data calculations.

OTHER SERVICES: Compressed air is provided at 100 psi and at 16 lb/sec max. flow rate; Water, 75 gal/min at 100 psi; Electrical power, 440V, 3 Phase, 60 Hz; 110V, 400 Hz; 110V, 60 Hz; 28 Vdc.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1969 COST \$ ESTIMATED REPLACEMENT VALUE \$ Not Available
CONTRACTOR:	
IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: None



#### FACILITY PERFORMANCE DATA

Total Temperature:	Ambient
Total Pressure:	Ambient
Mass Flow Rate:	Unlimited, as required by engine
Run Time:	Continuous
Maximum Engine Thrust	
Measuring Capability (1bf):	100,000
	(Thrust frame capacity)

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	300,000 gal	Delivery (0 to 100)	185,000	Ambient

## GE STATIC SEA LEVEL TEST CELL NO. 5

REPORTING INSTALLATION: General Electric Company Cincinnati, Ohio 45215	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Test Facilities Engineering Evendale, Ohio
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Test Facilities Engineering Phone: (513) 243-4964

## DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This is a static sea level test cell with the capability to heat air induced by the engine as it is drawn through a horizontal acoustically treated 20 foot by 20 foot test chamber. Heaters located in this area can heat the inlet air to 150°F (2 x 10<sup>6</sup> Btu/hr) at up to 2000 lb/sec. A filtration screen (24 mesh x .0075 inch wire) is located in the inlet stack. The exhaust system consists of a 10 foot diameter water cooled augmenter connected to a blast suppressor in the sound controlled vertical exhaust stack. The engine is mounted on an overhead thrust frame capable of up to 100,000 lb thrust loads. An 18 by 56 by 12 foot control room is located adjacent to the test chamber, providing engine and auxiliary controls, thrust measuring systems, fuel flow measuring systems, and temperature, vibration and pressure instruments for engine operation and control.

**ALTERNATE FACILITIES:** Three other facilities are available. Cells 6 and 7, which are nearly identical to the subject test cell, and Cell 2, which is similar to Cell No. 5.

**TESTING CAPABILITIES:** Automatic data handling (ADH) capabilities include: 400 pressures, 392 temperatures, 10 frequencies (fuel flows and speeds), 24 bridge circuits, 10 vibration channels and 16 digital inputs. The ADH has the capability of recording transient data. (Up to 400 analog channels can be recorded at speeds from 200 to 10K channels per second.) Engine performance data are available within two minutes after initiation of a normal ADH reading.

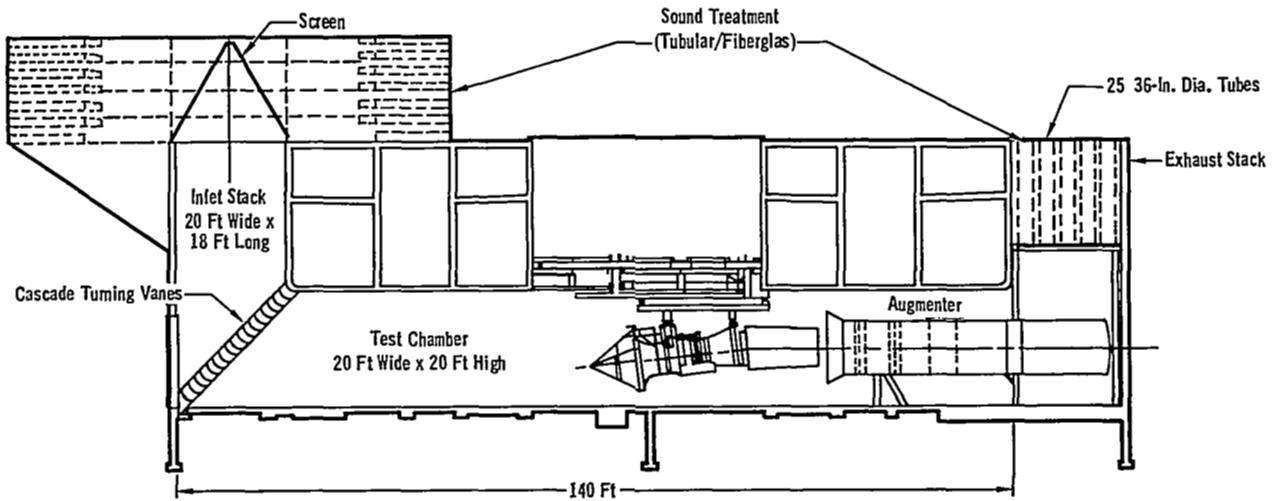
**OTHER SERVICES:** Compressed air is provided at 100 psig at 12 lb/sec max. flow rate and 300 psig at 60 lb/sec max. flow rate; Water, 2000 gal/min; Electrical power, 60A; 440V, 3 phase; 110V, 60 Hz; 110V, 400 Hz; 28 Vdc.

## FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1953-55 COST \$ Not Available ESTIMATED REPLACEMENT VALUE \$ Not Available
CONTRACTOR:	
IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: None.

SCHEMATIC



FACILITY PERFORMANCE DATA

Total Temperature ( $^{\circ}$ R): 610  
 Total Pressure: Ambient  
 Mass Flow Rate (lb/sec): 2500  
     (Induced by Engine)  
 Run Time: Continuous  
 Maximum Engine Thrust  
 Measuring Capability (lb<sub>f</sub>): 100,000  
     (Thrust frame capacity)

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range ( $^{\circ}$ F)
Hydrocarbons	850,000 gal	Delivery (0 to 90)	160,000	Ambient

GRUMMAN ENGINE TEST FACILITY

REPORTING INSTALLATION: Grumman Aerospace Corporation Bethpage, Long Island New York 11714	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Engineering - Power Plant Design - Dept 345 Production - Engine Dept - 06051
OTHER SOURCES OF INFORMATION: Not Available	LOCAL OFFICE TO CONTACT FOR INFORMATION: J. Trahnstrom - Cognizant Engr - Dept 345 - Plt 06 Calverton, New York 11933 Phone: (516) 727-1500, ext 437

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** Centered on a 35,000 square foot concrete area, the Engine Test House consists of two enclosed static test cells located on either side of an integral concrete and steel control room. An adjacent pump house and underground fuel storage area together with an equipment bay above the control room comprise the auxiliary structures. The 15 by 30 foot cells A and B, rated for 30,000 and 50,000 pounds, respectively, contain standard 48 inch rail system engine stands equipped with "Emery" thrust measuring systems. A "Cardox" Fire Detection and Extinguishing system is integrated with a general alarm circuit, with electrically operated doors enclosing each cell. Built-in fuel, hydraulic, compressed air, water and electrical lines service both cells. Instrumentation and hydraulic junction boxes provide interface with the control room. Engine power control is maintained by a direct cable system from the throttle on the operator's console. The air conditioned, sound attenuated control room houses separate operator's and engineering consoles, duplicated for cells A and B. These contain all necessary direct reading instruments for monitoring J52 series Turbojet and TF30 series turbofan engines. Other engines of the same type could be accommodated with minimum alteration to existing equipment.

**TESTING CAPABILITIES:** The Engine Test House is used for operating turbojet and turbofan engines at sea level static conditions with both bellmouth and simulated airframe inlets. With the standard instrumentation provided, many phases of engine functional checking, trim, and troubleshooting procedures can be conducted. These include horsepower studies, both bleed air extraction and electrical generator loading; vortex destroyer system testing; starter torque testing; and temperature and vibration studies. Employing the special test equipment, a comprehensive engine-inlet compatibility study can be conducted. Engine component and auxiliary systems testing is possible for afterburners, inlets, and fuel control systems. Applicable engine types are turbojet and turbofans (both dry or w/afterburners).

**RECORDING CAPABILITY:** Standard Equipment: Honeywell 12 channel 350 cycle Visu-Corder. Special Test Equipment: Digital-computer-controlled acquisition system includes signal conditioning, filtering, 64 channel low level multiplex, frequency response of 10 Hz and full scale error tolerance of less than  $\pm 1\%$  millisecond resolution. It is composed of general purpose computer with "8K" memory; a tape control unit; a 7 track - 1/2 inch digital tape transport; 12 column, 40 lines per second alpha-numeric "on-line" printer; an on-line typewriter; a time display; and associated electronics. Analog-Constant Bandwidth Acquisition System includes 40 high frequency (1000 Hz) channels of constant bandwidth  $\pm 4$  KHz V.C.O.'s, FM Multiplexing and recording electronics, and a 7 track - 1/2 inch intermediate band analog tape transport. A full Data Reduction Facility is operated in a nearby plant located on the Grumman-Calverton complex.

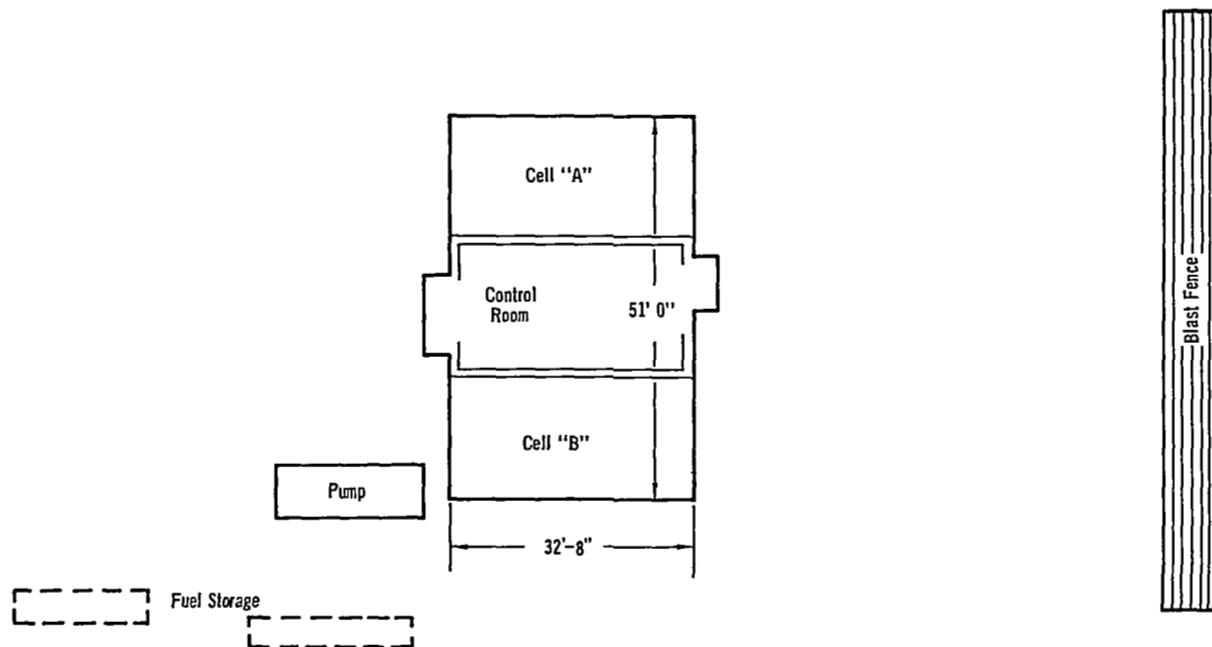
\*Note Below: (a) Production Engine Operations (8 Hour Shift): Includes engine trim and troubleshooting plus overhead, fuel, and manpower; (b) Engineering Test Operations (8 Hour Shift): Includes overhead, fuel, and manpower.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING *(a) \$650/shift COST (TYPICAL 8 HOUR SHIFT): (b) \$1200/shift	CONSTRUCTION YEAR: 1955 COST \$226,000 ESTIMATED REPLACEMENT VALUE Not Available LOCATION: New York
<b>CONTRACTOR:</b> James Stewart and Co.	
<b>IMPROVEMENTS AND COSTS:</b> (1968-69) Engineering Support Equipment: improved data monitoring equipment, engine power control system, fuel supply modification, and 48 inch rail system thrust stand, Cost \$400,000; (1968-69) Facilities Department Improvements: augmented concrete base for thrust stand, improved fuel pumping and filtration system, air conditioning, electrical services, Cost \$50,000; (1968-69) Special Data Acquisition Equipment: SE 6 Data System includes related signal conditioning and amplifier equipment, Cost \$200,000.	

PLANS FOR FACILITY IMPROVEMENTS: None.

## SCHEMATIC



**FACILITY PERFORMANCE DATA**

Total Temperature: Ambient  
Total Pressure: Ambient  
Mass Flow Rate: Unlimited, as required by engine  
Maximum Engine Thrust  
Measuring Capability (lbf): Cell No. A: 35,000 at 6 ft. centerline  
Cell No. B: 50,000 at 6 ft. centerline

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons (JP5)	15,000 gallons	48	74,000	Ambient

## LTV SEA LEVEL ENGINE TEST CELL NO. 3

REPORTING INSTALLATION: LTV Aerospace Corporation P.O. Box 5907 Dallas, Texas 75222	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Engineering Laboratories
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: R. R. Raven, Chief, Structs & Systems Labs Phone: (214) 266-5764

## DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This static sea level test cell is operated in the continuous mode. The test cell is 32 feet wide by 44 feet long by 16 feet high. The engine is controlled from an adjacent room with windows overlooking the test article. Photo-coverage (normal and high speed) is available for specific test conditions.

**ALTERNATE FACILITIES:** An alternate test cell (No. 4) is available with capabilities identical to the subject test cell.

**TESTING CAPABILITIES:** This facility is used for testing turbojet, turbofan and turboprop engines at sea level conditions. The cell has a control room and data recording area adjacent to the test cell. The data system is a real time hybrid system using a Sigma 3 and a Sigma 7 computer. The system can acquire and process up to 450 channels of data. Sampling rates vary from 40 channels per second to 20,000 channels per second.

Engine dynamic simulation is available by utilizing engine variable geometry control or engine fuel control.

Engine components and auxiliary systems testing is possible for afterburners (turbojets and turbofans) and for fuel control systems, exhaust nozzles, heat exchangers, inlets, and variable geometry control (turbojets and turbofans, dry and with afterburner; turbofans with duct burning).

**OTHER SERVICES:** Auxiliary air is available at 5 lb/sec at 115 psia; Hydraulic services, 80 gal/min at 5000 psia.

\* Note Below: Based on assumptions that a test engineer, technicians, instrumentation engineer, instrumentation technician, data acquisition system, and expendable materials (fuel, etc.) would be furnished with the facility.

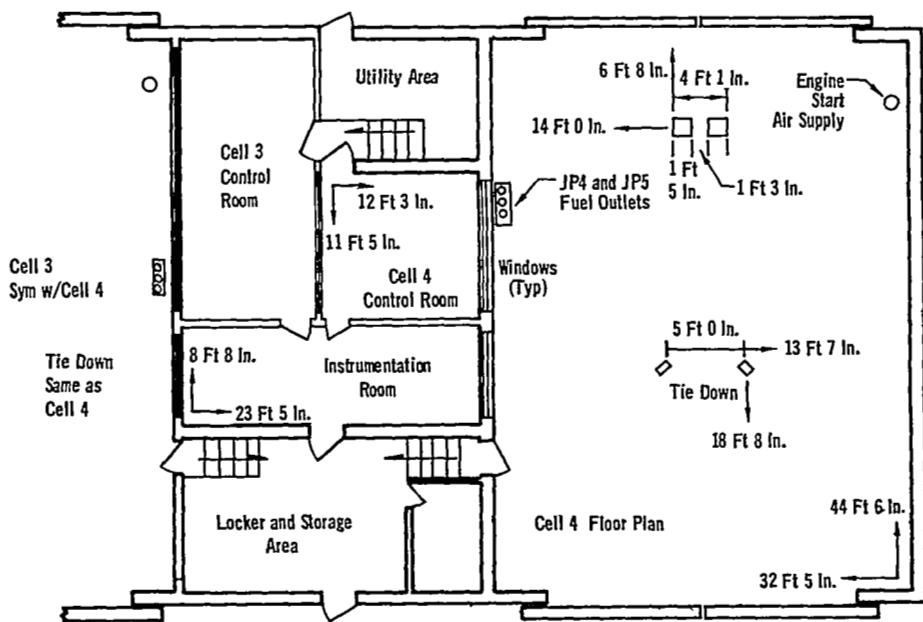
\*\* Note Below: The laboratory engine test capability is a part of the production engine facility. It is not practical to separate the cost of the laboratory apart from the whole facility.

## FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$1500 * (Estimated)	CONSTRUCTION YEAR: COST \$ Not Available ESTIMATED REPLACEMENT VALUE \$250,000**
CONTRACTOR: LTV Aerospace Corporation	LOCATION: Dallas, Texas
IMPROVEMENTS AND COSTS:	

PLANS FOR FACILITY IMPROVEMENTS: (1) Additional pumping capacity to 120,000 lb/hr; (2) Thrust measuring capability to 60,000 lbf.

## SCHEMATIC



#### FACILITY PERFORMANCE DATA

Total Temperature:	Ambient
Total Pressure:	Ambient
Mass Flow Rate:	Unlimited, as required by engine
Run Time:	Continuous
Maximum Engine Thrust	
Measuring Capability (1b <sub>f</sub> ):	50,000

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	8000 gallons		60,000	

LOCKHEED-GEORGIA SEA LEVEL ENGINE TEST STAND NO. 1

REPORTING INSTALLATION: Lockheed-Georgia Company 86 S. Cobb Drive Marietta, Georgia 30061	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: Engineering Flight Test
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: George Hines Phone: (404) 424-3701 or 424-3776

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is an open air (static) test stand originally built for C-141A engine testing and then modified for the C-5 engine. The stand consists of a structural steel framework enclosing a thrust cradle suspended by flexure straps. Thrust measuring capability (a Hydraulic Emery Cell) exists to measure forward and reverse thrust up to 60,000 and 30,000 pounds respectively. The stand was structurally designed for 100,000 pounds capability. The thrust cradle was designed to accept a C-5A pylon and engine/nacelle mounted at C-5A inboard height. The stand is controlled from a sound proof blockhouse with complete capability for mounting instrumentation of all types.

ALTERNATE FACILITIES: A second test stand (No. 2) is available at the same test pad which utilizes the same control room as the subject test stand. This is an open air (static) stand built for endurance testing of the C-5A outboard pylon and engine/nacelle.

TESTING CAPABILITIES: This facility is used for providing performance and endurance test capability. Applicable engine types are turbojets (dry and w/afterburner), turbofans (dry and w/afterburner), and turbofans (w/duct burning). The performance test stand (No. 1) includes facilities for loading the complete power package components for functional checkout, that is, hydraulic pump loading and cooling, pneumatic bleed and generator load. The endurance stand (No. 2) is presently configured only for functional testing of the engine/nacelle and only aircraft cockpit type instrumentation is available.

\*Note below: (a) Performance Stand  
(b) Endurance Stand

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): (a) \$1000/Shift (b) 800/Shift	CONSTRUCTION YEAR: 1961 ESTIMATED REPLACEMENT VALUE \$1,200,000
CONTRACTOR: Lockheed-Georgia Co	LOCATION: Marietta, Georgia
IMPROVEMENTS AND COSTS: (1966) Add control room, concrete test stand pad, blast fence, fuel storage system, and two test stands, Cost \$416,300.	
NOTE: Costs do not include land cost located on government property.	
PLANS FOR FACILITY IMPROVEMENTS:	

SCHEMATIC

(Not Available)

FACILITY PERFORMANCE DATA

Total Temperature: Ambient  
Total Pressure: Ambient  
Mass Flow Rate: Unlimited, As Required by Engine  
Altitude: Sea Level  
Maximum Engine Thrust 60,000 (forward)  
Measuring Capability (lb<sub>f</sub>): 30,000 (reverse)

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbon (JP-4)	25,000 gallons			

NAVAL AIR TEST CENTER  
SEA LEVEL ENGINE THRUST STAND

REPORTING INSTALLATION: Naval Air Test Center Patuxent River, Maryland 20670	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Airborne Measurements and Standards Laboratory Unit
OTHER SOURCES OF INFORMATION: "Navy Technical Facility Register", NAVMAT P-3999, 1968.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Technical Services Branch (TSD) Phone: (301) 863-3111, ext 4448

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This thrust stand is a "T" shaped structural steel floating platform, suspended on four stainless steel flexures so as to resist side sway resulting from off center loading generated by single engine calibrations. The main body of this floating platform, plus the extension, can accommodate aircraft whose nose to main gear is not more than 30 feet and whose main to main gear is not over 20 feet.

TESTING CAPABILITIES: The thrust detection system is composed of two precision electronic load cells of 1/10% accuracy, each with dual strain gage bridges to give 2 independent outputs. These cells are placed in the extreme lateral points of the stand. The output signal of the primary bridges is paralleled into a millivolt meter. The output signal of the secondary bridges is paralleled into an oscillograph to give dynamic records of thrust for time histories and event marking. The thrust capacity is 40,000 lbs and the vertical load limit is 80,000 lbs at this time.

The system is calibrated to read 20 lbs per division on the millivolt potentiometer with a guaranteed year round system accuracy of 1% of reading from 5000 lbs to 25,000 lbs and plus (+) or minus (-) 30 lbs from zero to 5000 lbs.

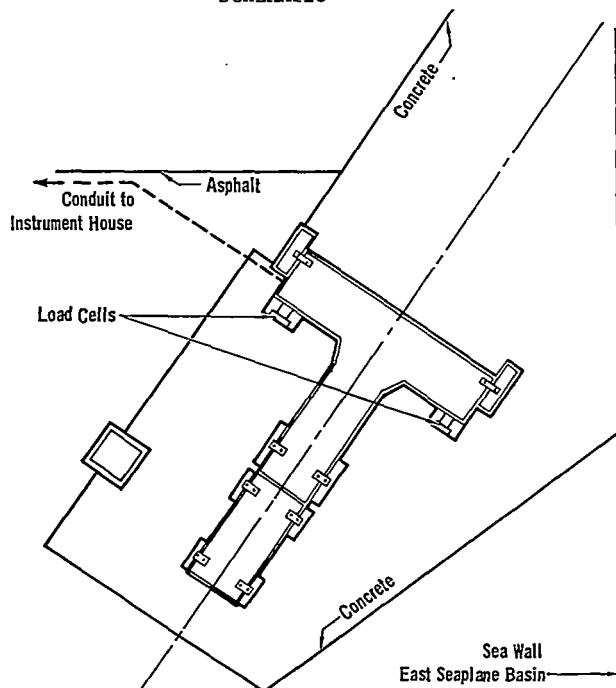
The thrust indicating and support instrumentation is housed in a brick instrument house located 100 feet west of the stand. Instruments included are: strip chart recorder, recording wind direction and velocity; aneroid barometer; psychrometer, six channel recording oscillograph; radio transmitter base station for communicating with shop and portable transceivers which are used by pilot and ground support personnel during calibrations.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$180	CONSTRUCTION YEAR: 1953 COST \$ 40,000 ESTIMATED REPLACEMENT VALUE \$125,000
CONTRACTOR: Thiokol Chemical Corp., Hunter-Bristol Div.	LOCATION: Bristol, Pennsylvania
IMPROVEMENTS AND COSTS: (1957) Instrument house building No. 182, Cost \$9006; (1965) 12 ft extension, and changed load cells and readout, Cost \$35,000.	

PLANS FOR FACILITY IMPROVEMENTS: Thrust capacity to be increased to 60,000 lbf.

## SCHEMATIC



#### FACILITY PERFORMANCE DATA

Total Temperature:	Ambient
Total Pressure	Ambient
Mass Flow Rate:	Unlimited, as required by engine
Run Time:	Continuous
Maximum Engine Thrust	40,000 (Planned
Measuring Capability (1bf):	expansion to 60K)

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Not Available				

NORTH AMERICAN ROCKWELL/COLUMBUS  
SEA LEVEL ENGINE TEST CELL

REPORTING INSTALLATION: North American Rockwell Columbus Division 4300 E. 5th Avenue Columbus, Ohio 43216	STATUS OF FACILITY: Standby COGNIZANT ORGANIZATIONAL COMPONENT: Production Flight Test Department
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Aero Thermo Laboratories Phone: (614) 231-1851, ext 2396

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This sea level static engine test cell is operated in the continuous mode with air supplied at ambient conditions. The test cell dimensions are 52 feet wide, 70 feet long and 22 feet high. The engine operator may monitor engine operation visually by means of large windows installed between the control room and test area as well as by remote TV. Engine exhaust is ducted to atmosphere at up to 4950K cfm through concrete walls lined with acoustical panels cooled by secondary airflow and water. A 200,000 gallon cooling water storage capability is available with water flow rate to 2800 gal/min.

**TESTING CAPABILITIES:** The engine test cell is designed and equipped to obtain jet engine transient and stabilized performance characteristics, including thrust evaluation, impingement starting tests, compressor pressure and bleed flow determination, inlet duct evaluation, fuel and oil system testing, ac and dc power system evaluation, and torque booster tests. Applicable engine types are turbojets (dry and w/afterburner), turbofans (dry and w/afterburner), and turbofans (w/duct burning). The facility is also used to troubleshoot malfunctions and develop components and operating techniques to increase performance and reliability. Capabilities also include the testing of rocket engines up to 10,000-pound thrust. Data recording is accomplished with direct writing oscilloscopes with 36 available data channels.

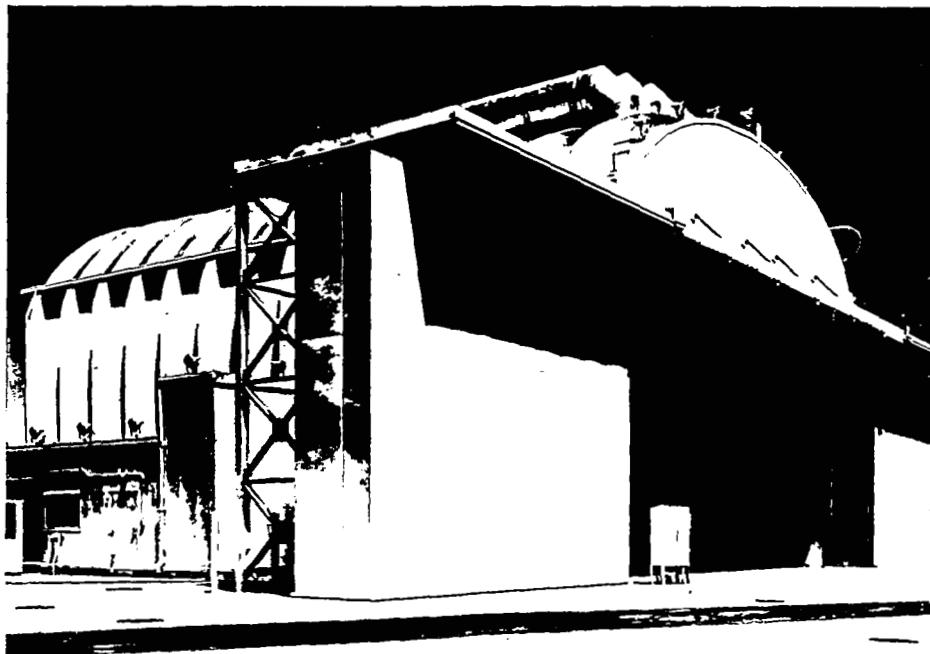
**OTHER SERVICES:** Auxiliary air is available for 4000 cfm at 300 psia (utilized for turbine impingement starting); and a hydraulic reservoir is available at 3000 psia (utilized for engine mounted hydraulic pumps).

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1958 COST \$ 912,000 ESTIMATED REPLACEMENT VALUE \$2,190,000
CONTRACTOR: Green Fuel Economizer Co.	LOCATION: Beacon, New York
IMPROVEMENTS AND COSTS: (1962) Increase inlet/exhaust capability, Cost \$152,000.	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA

PERFORMANCE PARAMETERS

Total Temperature: Ambient  
Total Pressure: Ambient  
Mass Flow Rate: As required by engine  
Maximum Altitude: Sea Level  
Run Time: Continuous  
Maximum Engine Thrust  
Measuring Capability (lb<sub>f</sub>): 50,000

FACILITY PERFORMANCE DATA				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	20,000 gallons	Ambient	102,000	Ambient

NAR/LOS ANGELES PROPULSION SYSTEMS TEST FACILITY  
(Santa Susana, California)

REPORTING INSTALLATION: North American Rockwell Los Angeles Division International Airport Los Angeles, California 90009	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Research and Engineering Division
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: E. Freschl Mechanical and Propulsion Department Phone: (213) 670-9151, ext 2841

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility consists of four static sea level engine test stands. The remote location permits high noise level and high-risk testing.

TESTING CAPABILITIES: This facility tests turboprop, turbojet, small rocket, and reciprocating engines with their associated components. A sound suppressor is available for a J-93 engine size with a 40 dB sound pressure level reduction capability.

A 154 channel electronic data recording system is available to record all types of high and low level data signals. A wide variety of data sensors are stocked on site. Data can be recorded on high speed digital tape for direct processing by IBM computing equipment. Also available are a direct writing recorder for immediate on-site analysis and a photographic oscilloscope for high frequency data evaluation.

OTHER SERVICES: Hydraulic services are available at 80 gal/min and 150 gal/min at 4000 psi; electrical load bank, 60 kW; a motor generator, 5 kW, 120/208V; and water, 40,000 gallon storage tank. Engine and test equipment supporting shops are available on site.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: COST \$ ESTIMATED REPLACEMENT VALUE \$	Not Available
CONTRACTOR:	LOCATION:	
IMPROVEMENTS AND COSTS: Not Available		

PLANS FOR FACILITY IMPROVEMENTS: Not Available

## SCHEMATIC

(Not Available)

## FACILITY PERFORMANCE DATA

Total Temperature:	Ambient
Total Pressure:	Ambient
Mass Flow Rate:	Unlimited, as required by engine
Maximum Run Time:	Continuous
Maximum Engine Thrust	
Measuring Capability (lb <sub>f</sub> ):	60,000

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons	40,000 gallons			

NORTHROP ENGINE TEST CELL

REPORTING INSTALLATION: Northrop Corporation, Aircraft Division 3901 West Broadway Hawthorne, California 90250	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Systems Test Laboratory
OTHER SOURCES OF INFORMATION: Northrop Report NB 67-253, "Engineering Labs. Research & Test Facilities", November 1967	LOCAL OFFICE TO CONTACT FOR INFORMATION: Hugo Pink, Manager, Dept. 3460 Flight and Laboratory Test Phone: (213) 675-4611, ext 1312

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This sea level static test cell measures 30 by 100 by 19 feet clear height (inside dimensions) and is sound attenuated.

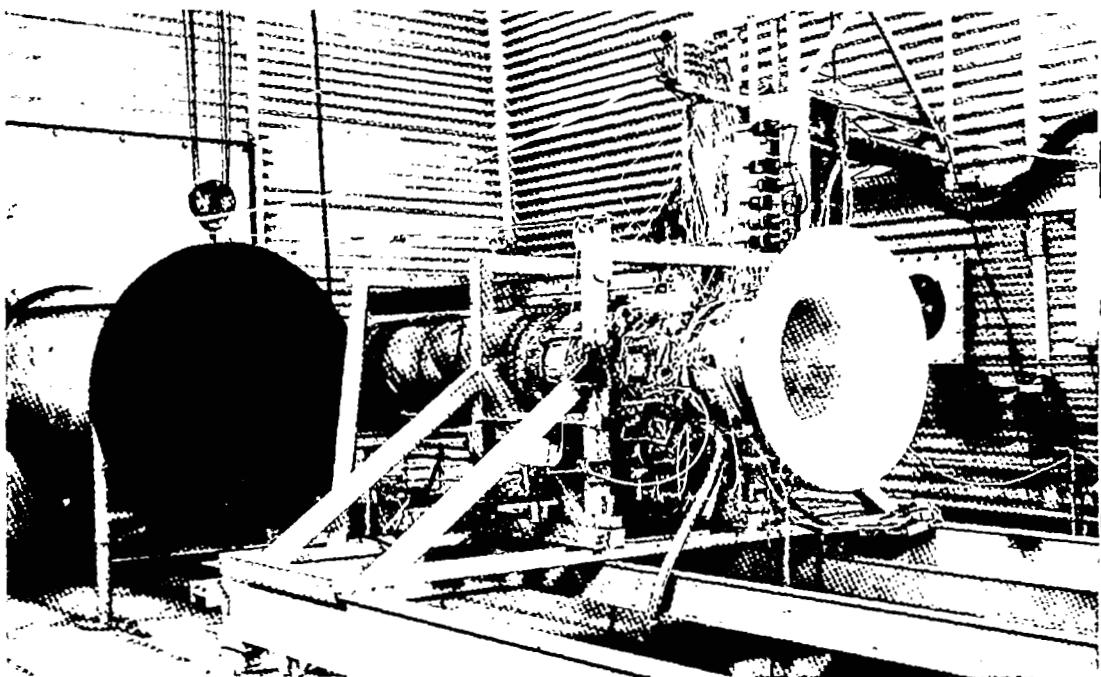
TESTING CAPABILITIES: Equipment and instrumentation include: (1) A TV monitoring circuit (three remote controlled cameras: two fixed, one portable), (2) Four photomanometer boards, (3) 300 electrical circuits, (4) 300 pressure channels, (5) 400 temperature channels, (6) 40-channel photopanel recorder, (7) Magnetic tape and IBM card data recording, and (7) A Boeing model 502-11B air start cart.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1956	COST \$462K Approx.
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$	Not Available
IMPROVEMENTS AND COSTS: Not Available	LOCATION:	

PLANS FOR FACILITY IMPROVEMENTS: Not Available

SCHEMATIC



FACILITY PERFORMANCE DATA

Total Temperature: Ambient  
 Total Pressure: Ambient  
 Mass Flow Rate: Unlimited, as required by engine  
 Maximum Run Time: Continuous  
 Maximum Engine Thrust  
 Measuring Capability (lbf): 20,000 (Expandable to 40,000)

## ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons (JP-4 or JP-5)	10,000 gal	Ambient	80,210 @ 50 psi by-pass system	Ambient

## UAC SEA LEVEL ENGINE TEST STAND NO. X-8

REPORTING INSTALLATION: United Aircraft Corporation Pratt and Whitney Aircraft Division Experimental Test Laboratories 400 Main St.; E. Hartford, Connecticut 06108	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Experimental Test Department
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: J. L. Preston, Supervisor, Experimental Test Facilities; Facilities Office, Willgoos Laboratory Phone: (203) 565-8809

## DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This test stand is a sea level, static, full scale engine test stand with a test section cross-section 33 by 33 feet and an inlet length of approximately 55 feet. A direct fired natural gas inlet air heater rated at 2000 lb/sec is used to provide air at 120°F. By the use of three-stage burner nozzles, all burners are lit at minimum airflow conditions, thereby yielding the minimum temperature variation across the engine inlet. During operation, engine exhaust gases are directed into a cylindrical ejector duct. There they are mixed with cooling air aspirated into the test cell by the ejector action of the engine exhaust stream as it enters the duct. The inlet of the cylindrical duct ejector is adjustable over a range of 8 feet so that it may be positioned in the optimum location relative to the engine nozzles. In addition, this system is provided with an ejector spoiling device and remotely controlled secondary air inlet dampers to modulate the pumping action of the ejector. These devices allow setting of the cell pressure throughout the complete operating range to permit matching of engine inlet pressure to cell pressure in order to reduce stand performance corrections. Instrument connections are made from instrument pods to stand panels utilizing multi-unit connecting devices designed for rapid installation. The stand panels are permanently connected to the appropriate readout or transmitting device located in the control room, automatic data system room or to special mobile instrumentation van.

**ALTERNATE FACILITIES:** Thirty-two alternate sea level static test stands of various sizes are available. These include 5 stands with airflow capability from 1500 to 2000 lb/sec, 6 stands with heated inlets to 120°F and 6 with automatic data systems similar to X-8.

**TESTING CAPABILITIES:** This facility is used to conduct developmental tests on current and advanced air-breathing engines at sea level static conditions. Equipment and instrumentation permit engine steady state performance tests, endurance tests, transient tests, strain gage analysis, water injection tests, and all other developmental tests required of a complete engine. Applicable engine types are turbojets (dry and w/afterburner), turbofans (dry and w/afterburner), and turbofans (w/duct burning). The steady state data system serves this stand with 687 available data channels which are transmitted to an on-line computer. Data and performance results are displayed on a line printer in the control room promptly after the data are requested. Transient data may be recorded by mobile van through an exterior panel. Four hundred data channels are available.

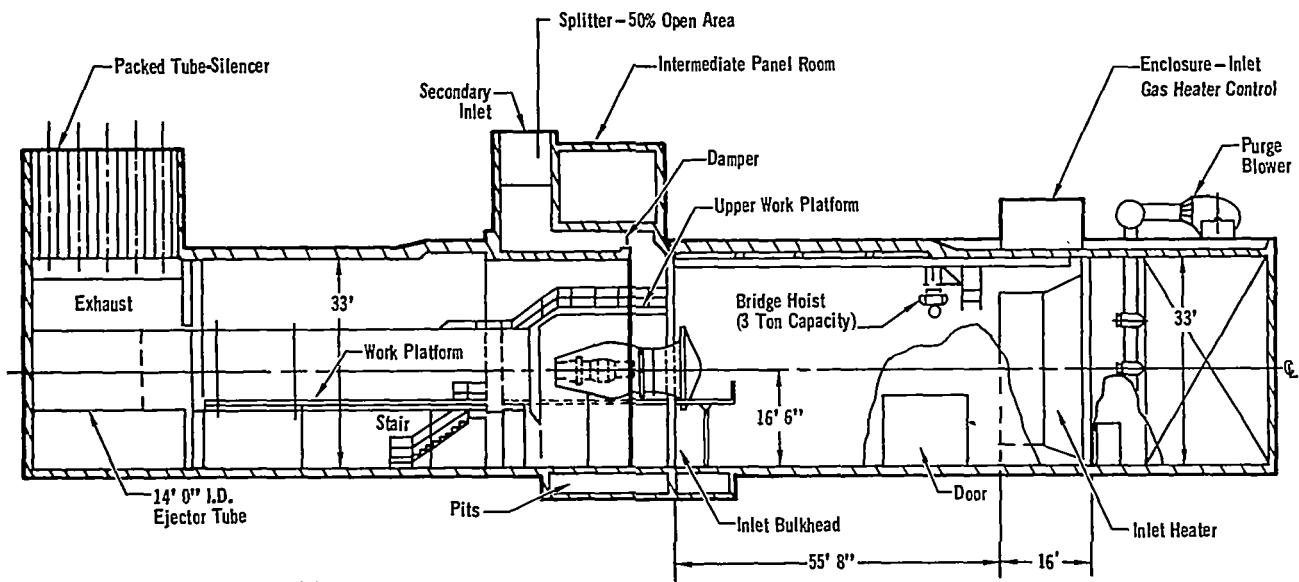
**OTHER SERVICES:** One hundred psig shop air primarily for instrumentation, controls and engine starting; 110 and 440 volt 60 Hzac; and 24 volt dc electrical power supplies; 125 psig industrial water; test cell water fog fire system; 25 psig steam; high pressure (740 psig) demineralized water; a variety of fuel supplies; and a hydraulic system to operate the test cell work platforms.

## FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: ESTIMATED REPLACEMENT VALUE \$	COST \$ Not Available
CONTRACTOR:	LOCATION:	
IMPROVEMENTS AND COSTS: Not Available.		

PLANS FOR FACILITY IMPROVEMENTS: Not Available.

SCHEMATIC



Note: Access to Test Cell 14' Wide x 15' High.

FACILITY PERFORMANCE DATA

PERFORMANCE PARAMETERS

Total Temperature ( $^{\circ}$ R): To 580  
 Total Pressure (psia): 14.7  
 Mass Flow Rate ( $lb_m$ /sec): 2000 (Induced)  
 Maximum Run Time: Continuous  
 Maximum Altitude (feet): Sea Level  
 Maximum Engine Thrust  
 Measuring Capability ( $lb_f$ ): 75,000

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery ( $lb_m$ /hr)	Temperature Range ( $^{\circ}$ F)
Hydrocarbons (JP Type)	8,000,000 gal (for all test cells)	Ambient	110,000	Ambient

## UAC SEA LEVEL OUTDOOR TEST STAND NO. X-314

REPORTING INSTALLATION: United Aircraft Corporation Pratt and Whitney Aircraft Experimental Test Laboratories 400 Main Street; E. Hartford, Conn. 06108	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Experimental Test Department East Hartford, Connecticut
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: J. L. Preston, Supvr, Experimental Test Facilities Facilities Office, Willgoos Laboratory Phone: (203) 565-8809

## DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This stand is an outdoor test facility designed to permit universal location of wind generating devices for engine crosswind testing and other auxiliary equipment for a series of other tests. These include limited engine performance tests, inlet and exhaust sound surveys, foreign object ingestion and thermal inlet distortion tests. Thirty foot high rigid steel frames anchored to a 30 by 40 by 6 ft concrete pad support the engine mount. This basic structure is designed for 100,000 lbs of thrust. The test engine is mounted from an overhead stationary mount adapter which is not presently capable of thrust measurement. The engine, predressed on the Experimental Assembly Floor with instrumentation pod and mount assembly, is delivered to the test facility on a special transport stand, lifted into position by a 40,000 lb hoist system and locked into the permanent mount structure. Instrument connections are then made from the instrument pods to stand booms which are permanently connected to the control room or a mobile van.

**ALTERNATE FACILITIES:** Three alternate test stands are available for outdoor testing. One of these, X-307, can provide the same capabilities as the subject stand in addition to forward and reverse thrust measurement to 75K lb force.

**TESTING CAPABILITIES:** This stand is capable of testing large turbofan or turbojet engines at outdoor ambient conditions. It is equipped for basic performance testing and, with auxiliary equipment positioned as required, is capable of running a series of special tests. The stand is located in an open area with unobstructed space for locating the crosswind generator. Crosswinds with velocities up to 65 miles per hour are generated by a P&WA R-4360 reciprocating engine driving a fourteen foot propeller. This engine, installed on a portable mount can be positioned as desired within a radius of 100 feet from the engine and, except for the exhaust jet stream, at any point around the test engine. The propeller wind may be directed generally toward the test engine at the desired angle or it may be directed through an auxiliary duct to provide more specific velocities and direction. Wind velocities, direction and their effects on the test engine are recorded by instrumentation in a mobile van. Thermal inlet distortion tests are run by mounting a 15 million Btu heater/burner in a segmented duct which is located ahead of the test engine. Duct location, mixing length within the duct and heater capacity can be varied as required. A permanently installed system of 20 microphones, spaced at ten degree intervals over a 180° arc is located in a 150 ft radius in a horizontal plane through the engine centerline. Microphone signals are routed through underground cables to the recording locations in the control room or a mobile van. Steady state instrumentation in the control room consists of approximately 300 channels. Up to 400 transient data signals can be transmitted to equipment mounted in a mobile van which is parked adjacent to the control room.

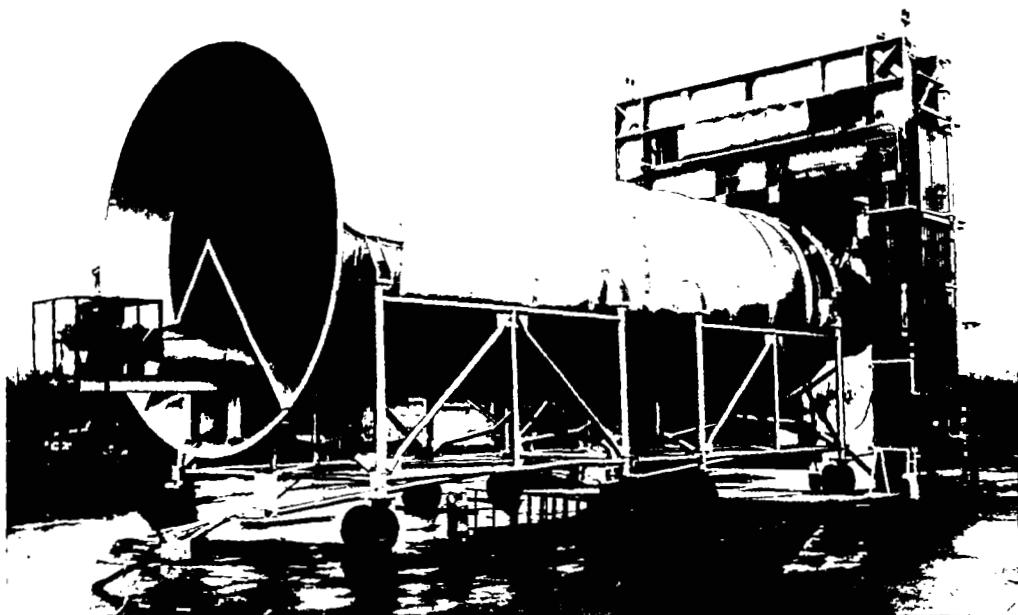
**OTHER SERVICES:** Six lb/sec of dry service air for instrumentation and engine starting; 120 and 480 volt, 60 Hz, 3 phase, and 120 volt, 400 Hz and 28 volts dc electrical power supplies, and up to 180 gal/min of water at 90 psig. This stand is also equipped with safety and fire protection equipment to control hazardous operating conditions and for use in case of emergency.

## FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: ESTIMATED REPLACEMENT VALUE \$	COST \$
CONTRACTOR:	LOCATION:	
IMPROVEMENTS AND COSTS:		

PLANS FOR FACILITY IMPROVEMENTS: None.

SCHEMATIC



FACILITY PERFORMANCE DATA

Total Temperature: Ambient  
Total Pressure: Ambient  
Mass Flow Rate: Unlimited  
(Outdoor Stand)  
Maximum Engine Thrust  
Measuring Capability (lbf): 100,000  
(Thrust frame  
capacity)

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lbm/hr)	Temperature Range (°F)
Hydrocarbons	32,000 gal	Ambient	80,000	Ambient

## UAC X-308 OUTDOOR TEST STAND ACOUSTICAL RESEARCH

REPORTING INSTALLATION: United Aircraft Corporation Pratt and Whitney Aircraft Division East Hartford, Connecticut 06108	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Experimental Test Department
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: J. L. Preston, Supervisor, Experimental Test Facilities, Willgoos Lab Phone: (203) 565-8809

## DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** The X-308 test stand is an outdoor facility in a remote location at Bradley International Airport in Windsor Locks, Connecticut, designed and equipped for noise research studies on various arrangements of gas turbine engine rotors. The specially designed noise research test vehicle consists of a rotating test section with provisions for a wide variation in the basic configuration. It is directly coupled to a modified two-stage jet engine turbine which is driven by a JT3C gas generator mounted 45° from the axis of the turbine. The turbine delivers 15,000 hp to the test vehicle over a speed range of 4000 to 8000 rpm. The stand has a portable canvas shelter for weather protection.

**TESTING CAPABILITIES:** The system arrangement permits a wide variety of capabilities relative to engine generated noise studies. These are outlined as follows: (1) Free field acoustical conditions, (2) Ability to provide any degree of distorted inlet airflow to the test vehicle, (3) Ability to take measurements of both inlet and discharge noise, (4) Operation with large or full scale test vehicles within power limitations, (5) Duplication of realistic fan blade loading and flow conditions for both high and low tip speed fans, (6) Generous range of rotor to stator spacing capability, (7) Ability to operate either with or without inlet guide vanes, (8) Ease of installation of acoustical treatment in the inlet and exit ducts, (9) Provisions for variation of inlet and fan exit duct length and nozzle area, and (10) Flexibility of operation to meet both current and long range test requirements.

A permanently installed system of 20 microphones, spaced at a maximum of 10 degree increments on a 150 ft radius is located on a semi-circle 0 to 180 degrees from the rig centerline. Recordings of the microphones are reduced for all speed points using 1/3 octave bandwidth filters. For this purpose, an automated analyzing console is available which provides digitized results of the analog tapes along with system response information. These results are then inputed to a computer which first corrects the data for system and microphone response and then proceeds to calculate various extrapolated noise factors such as PN dB, depending on the options selected. A narrow band spectrum analyzer in the control room provides preliminary information for tests in progress.

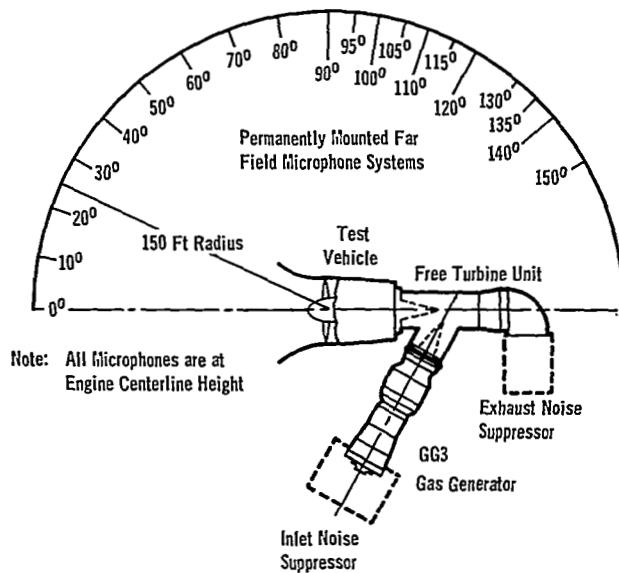
**OTHER SERVICES:** Auxiliary equipment includes a portable air compressor, exhaust silencers and a 28 volt generator. Stand services available to support testing include: a 120 psig compressed air system; 120 and 460 volt ac power; 90 psig city water (summer only); two shallow wells for limited winter operation; and JP type fuels piped from a tank farm with total capacity of 16,000 gallons.

## FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR:	COST \$ Not Available
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$	
IMPROVEMENTS AND COSTS: Not Available		

PLANS FOR FACILITY IMPROVEMENTS: Not Available

## SCHEMATIC



**FACILITY PERFORMANCE DATA**

Total Temperature: Ambient  
Total Pressure (psig): Ambient  
Mass Flow Rate (lb/sec): As Required by Engine  
Maximum Run Time: Continuous  
Maximum Engine Thrust  
Measuring Capability (lb<sub>f</sub>): Not Available

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons (JP Type)	16,000 gallons	Ambient	36,000	Ambient



3. SEA LEVEL TEST CELLS WITH RAM AIR

## GE RAM TEST CELL NO. 38

REPORTING INSTALLATION: General Electric Company Cincinnati, Ohio 44135	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Test Facilities Engineering Evendale, Ohio
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Test Facilities Engineering Phone: (513) 243-4964

## DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This test cell has a ram-air system capable of providing altitude or sea level static conditions at the inlet. The test section is 20 x 19 feet in cross-section. The ram-air system is capable of supplying a maximum of 400 lb/sec of air to the engine at temperatures of 560°R min to 1210°R, and pressures from ambient to 50 psia at the cell. The basic capacity of 300 lb/sec at 60 psia and 1210°R vitiated air is supplied by a 250,000 cfm axial flow compressor driven by a 32,000 hp synchronous motor with a 3250 hp starting steam turbine housed in Cell No. 1. An additional 100 lb/sec of air is utilized from the Building 401 air supply system. A 42 inch air line runs from the compressor discharge to an air heater. A 16 inch air line from the Building 401 air supply connects to the 42 inch line upstream of the heater. A 48 inch air line runs from the heater discharge to Cell Nos. 38 and 40. Inside Cell Nos. 38 and 40 are movable 6 foot diameter tanks which serve as air stilling chambers prior to the air entering the test engine. These chambers have three screens and one flow straightening tube bundle to produce uniform flow conditions to the test engine. The tanks are mobile for ease of engine transporting, and can be removed from the cells to provide sea level static conditions. Exhaust is vented to atmospheric conditions through a 7 foot diameter acoustically treated (tubular fiberglass) duct. The duct is water cooled with a maximum operating temperature of 960°R. A main control room for operation of the ram-air facility is located on a mezzanine next to the ram facility (Cell No. 1). All ram-air supply equipment is operated and all test inlet conditions are set from this control room.

**ALTERNATE FACILITIES:** An alternate facility (No. 40), with capabilities essentially identical to the subject test cell, is also available.

**TESTING CAPABILITIES:** Cell Nos. 38 and 40 share one control room, each having a full complement of control and measuring instrumentation for operation and monitoring test engine performance. Automatic data handling (ADH) is available. Cell No. 38 ADH consists of up to 400 pressures, 400 temperatures, 12 frequencies (fuel flow and speed), 34 bridge inputs, and 20 vibration channels. The Cell No. 38 ADH has the capability of recording transient data; up to 20 channels can be recorded at speeds from 15 to 9000 channels per second. Cell No. 40 ADH consists of 300 pressures, 392 temperatures, 10 vibration channels, 10 frequencies (fuel flow and speeds), and 24 bridge channels. The Cell No. 40 ADH equipment has the capability of recording transient data; up to 400 analog channels can be recorded at speeds from 200 to 10,000 channels per second.

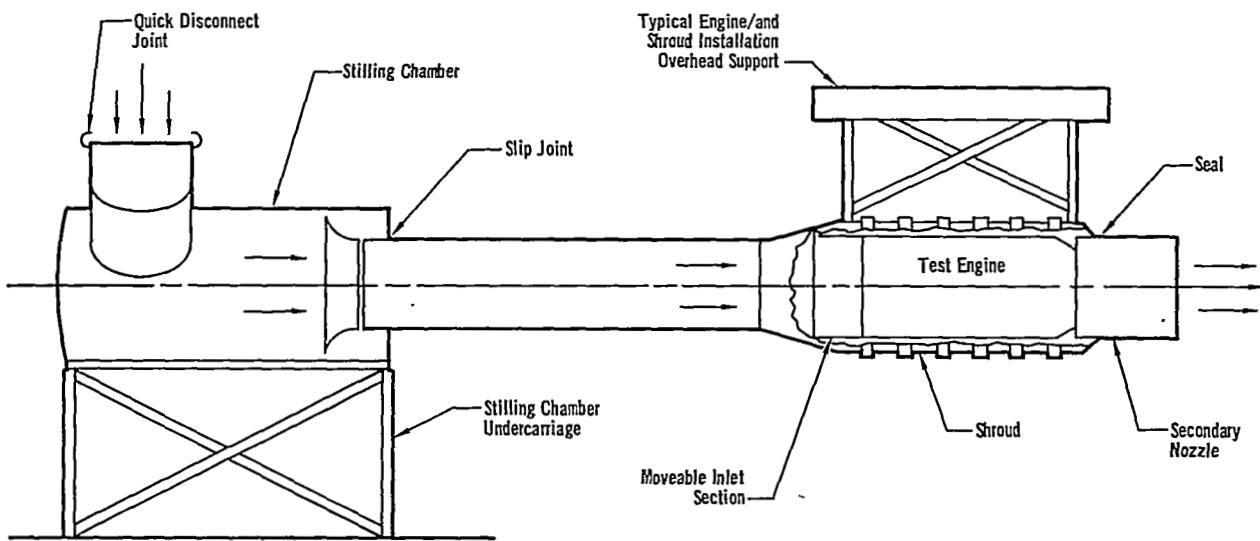
**OTHER SERVICES:** Air is provided at 100 psig dry and 300 psig; Water, 2000 gal/min; Electrical power, 60A; 440V, 3 Phase; 110V, 60 Hz; 110V, 400 Hz; 28 Vdc.

## FACILITY COST HISTORY

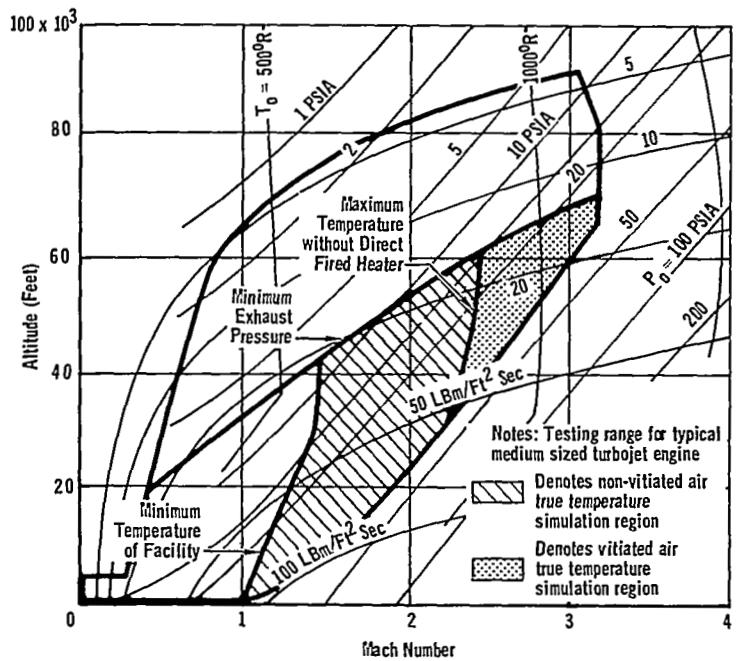
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1959 COST \$ ESTIMATED REPLACEMENT VALUE \$ Not Available
CONTRACTOR:	
IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 0 to 3.2  
 Total Temperature ( $^{\circ}$ R) Vitiated Air Source: 1210  
 Total Pressure (psia): 15 to 50  
 Mass Flow Rate (lb/sec)  
     Ram-air: 400  
     Sea Level: 1200  
 Maximum Altitude (feet): 80,000  
 Run Time: Continuous  
 Maximum Engine Thrust  
 Measuring Capability (lbf): 75,000  
 (Thrust frame capacity)

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range ( $^{\circ}$ F)
Hydrocarbons	850,000 gal	Delivery (0 to 90)	90,000	Ambient

MARQUARDT FULL SCALE SEA LEVEL CELL NO. 3  
(Air Force-Marquardt Jet Laboratories, Van Nuys)

REPORTING INSTALLATION: The Marquardt Corporation 16555 Saticoy Street Van Nuys, California 91409	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Test and Facilities Department
OTHER SOURCES OF INFORMATION: Marquardt Publication MP 1487	LOCAL OFFICE TO CONTACT FOR INFORMATION: Manager, Test and Facilities Department Phone: (213) 781-2121, ext 1203

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This sea level test cell is 40 feet long by 10 feet wide and has an 8-foot high by 5-foot thick sand filled protective barrier on each side. Air is ducted from the storage system through a vitiated heater or through a tube and shell indirect heater. A variety of free jet axisymmetric nozzles or direct connect bellmouths are available for positioning at the engine inlet. The available diameter sizes range from .58 to 2.67 feet. The angle of attack capability is +20° to -10°. The air supply to the cell is provided directly from a 630 psia air storage system through a 24-inch diameter, 630 psia air line. Water for cooling of the test item and exhaust gases is provided from a common industrial water system.

The test cell also can provide simulated altitude conditions at the inlet as shown in the envelope on the opposite page.

TESTING CAPABILITIES: This cell is used to test full scale airbreathing or integral rocket-ramjet engines under sea level flight conditions using a variety of Mach nozzles. Engine dynamic simulation is achieved by engine variable geometry control, engine fuel control, or free stream variation. All three methods are controlled by remote electrical or hydro-pneumatic systems. A TV system is available for test monitoring.

Engine components and auxiliary systems testing can be provided for afterburners of turbojets, turbofans, and turboramjets; combustors of turbojets, dry turbofans, turboramjets, and ramjets; compressors of dry turbojets with afterburners, dry turbofans with afterburners and duct burning, and turboramjets. Exhaust nozzles and inlets of all engines with compressors may be tested in addition to ramjet engines.

The test cell is connected to a central computer controlled digital/analog data acquisition system with 189 channels of data (10K samples/sec). The data reduction and dynamic data recording capabilities are provided at the same location.

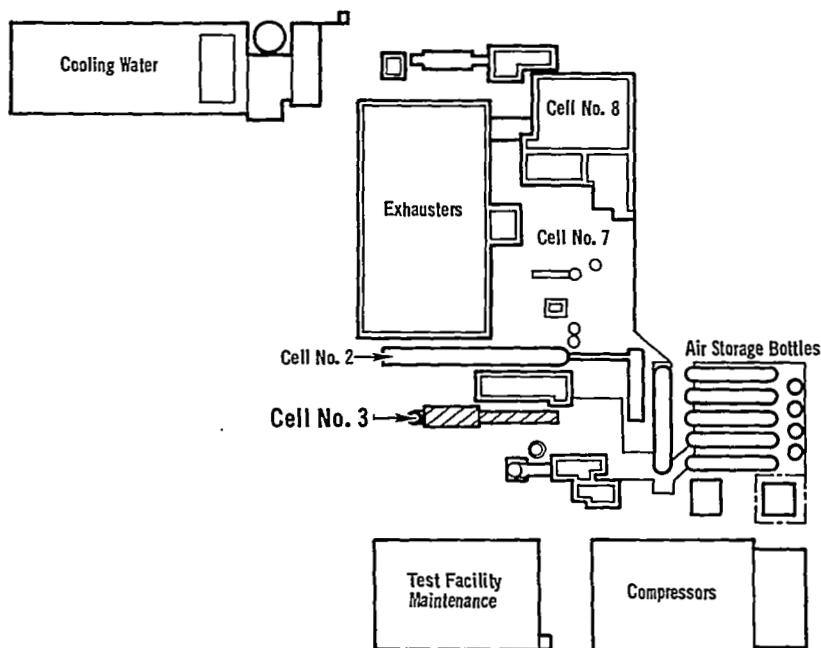
OTHER SERVICES: Service air is provided at 125 psia from a shop air system; hydraulic services, at 1000 psia from a central system.

FACILITY COST HISTORY

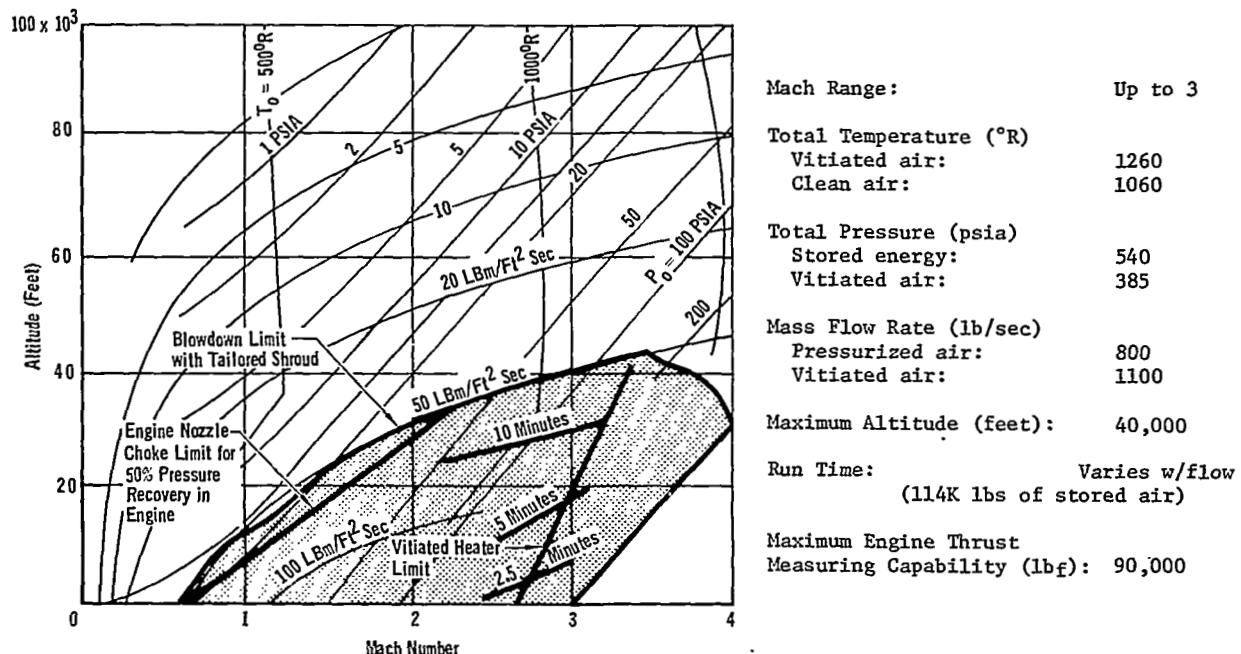
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$2240 (First Shift)	CONSTRUCTION YEAR: 1952 COST \$ 230,000 ESTIMATED REPLACEMENT VALUE \$1,200,000
CONTRACTOR: Kittel-Lacy	LOCATION: Los Angeles, California
CONSTRUCTION: A & E The Marquardt Co.	
IMPROVEMENTS AND COSTS: (1965) Blast barriers for 100 lbs TNT, Cost \$34,000; (1965) 600 psi air system, Cost \$77,000; (1965) Vitiated heater, Cost \$50,000; (1965) Gaseous oxygen system, Cost \$12,000; (1965) Sequencer system, Cost \$4000; (1965) Data system, Cost \$200,000.	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range ( $^{\circ}$ F)
Hydrocarbons	58,000 gallons	14.7	216,000	Ambient
Cryogenic Hydrocarbons	Available in portable tanks only			
Liquid Hydrogen	Available			

NAVAL AIR PROPULSION TEST CENTER  
ENGINE SEA LEVEL TEST CELL FACILITIES NO. 1W AND 2W

REPORTING INSTALLATION: Naval Air Propulsion Test Center P.O. Box 176 Trenton, New Jersey 08628	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aeronautical Turbine Department (NAPTC)
OTHER SOURCES OF INFORMATION: (1) NAPTC, "Aeronautical Turbine Department Test Facilities Description"; (2) "Navy Tech Facility Capability Register", NAVMAT P-3999, 1968.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Aeronautical Turbine Department Phone: (609) 882-1414, ext 239

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This test cell and an identical cell (No. 2W) are enclosed in test rooms 23 feet wide by 14 feet high and 56 feet long. The two sea level test cells are housed in a three level structure which includes the two test cells, a common control room with a direct view of the engine under test, a fuel room, an engine preparation room, and auxiliary areas. Liquid air from a 14,000 gallon storage tank is piped to the cell inlet to supplement mechanical refrigeration. The inlet section contains provisions for water ingestion and icing tests of engines. Design capability of the water ingestion system is 235 gallons per minute. Icing capability is 8 gallons per minute at 25 micron droplet size through 100 spray nozzles and 3.5 gallons per minute of 15 micron droplet size through 100 spray nozzles. Maximum continuous exhaust temperature is 3500°F at sea level.

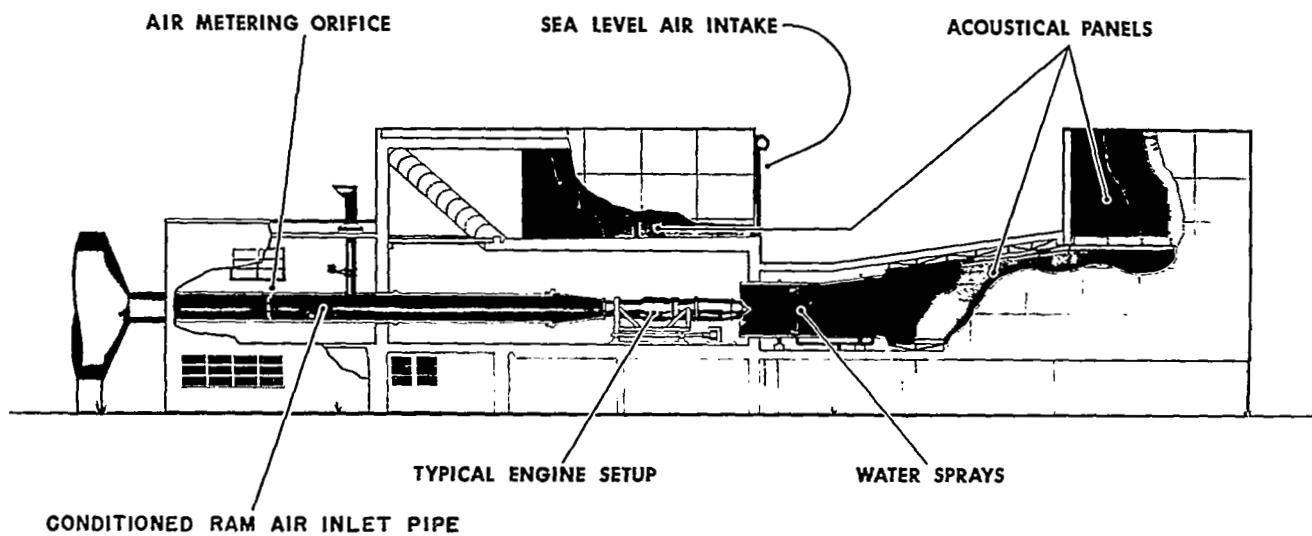
TESTING CAPABILITIES: This facility can be used to conduct verification of contractor's guarantee points, establishment of transient performance, windmill relight tests, high and low temperature starting and operation, water and steam ingestion tests, engine icing tests, and inlet pressure distortion tests. Engine instrumentation is standardized with all other test cells to provide quick disconnect couplings to mate with quick disconnect panels on the engine test stand in the test cell. Test instrumentation capability is provided through three groupings: (1) General monitor instruments, (2) Steady-state instrumentation, and (3) Transient instrumentation. The facility is connected to a central on-line data acquisition and computation system with type-out capability and a tape storage of engine performance data.

FACILITY COST HISTORY

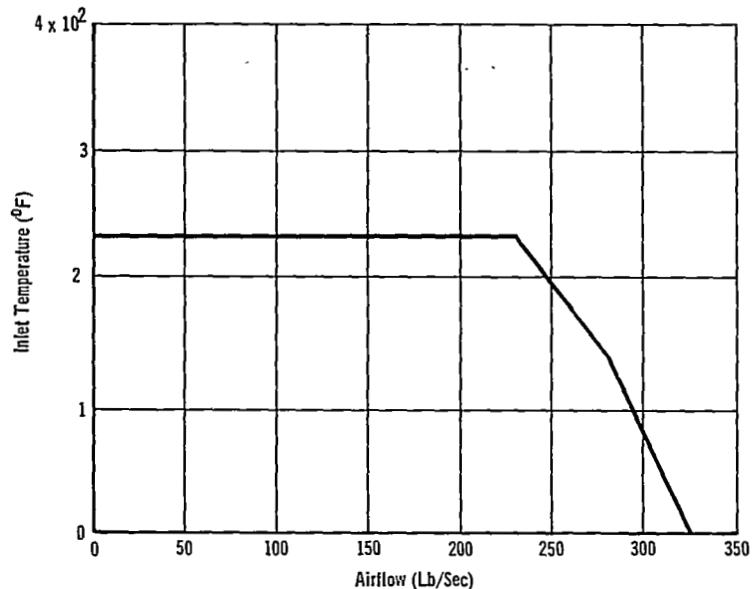
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1955 COST \$ 994,000/Cell
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$1,292,000/Cell
IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: Modernization is currently underway to increase effectiveness for cold soak programs.

SCHEMATIC



FACILITY PERFORMANCE DATA



PERFORMANCE PARAMETERS

Mach Range: To .9  
 Total Temperature ( $^{\circ}\text{R}$ ): 395 to 680  
 Total Pressure (psia): .83 to 29.5  
 Mass Flow Rate (lb/sec): 325  
 Maximum Run Time: Continuous  
 Maximum Altitude (feet): Sea Level  
 Maximum Engine Thrust  
 Measuring Capability (lb<sub>f</sub>): 20,000

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range ( $^{\circ}\text{F}$ )
Hydrocarbons	450K gal (for all test cells)	75		-70 to +150

ORDNANCE AEROPHYSICS LABORATORY  
SEA LEVEL TEST CELL NO. 1

REPORTING INSTALLATION: Service Technology Corporation P.O. Box 748 Daingerfield, Texas 75638	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: Service Technology Corporation, a subsidiary of LTV Aerospace Corporation
OTHER SOURCES OF INFORMATION: OAL, "Facility Handbook", Report 655, 1967.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Service Technology Corporation Phone: (214) 656-2211, ext 343

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This sea level test cell is operated in the continuous mode with an air supply from centrifugal compressors. The test cell dimensions are 13.8 ft wide by 14 ft high and 25.3 ft in length. Air temperature is raised and controlled using a gas fired heater. Exhaust gases pass into a steel-lined concrete stack and discharge to atmosphere. Large windows are installed in the cell wall for visual purposes. A shadowgraph is available for flow visualization. A telescope is installed in the discharge stack and is equipped for motion picture cameras.

ALTERNATE FACILITIES: An alternate test cell (No. 2) is available with identical capabilities to the subject test cell.

TESTING CAPABILITIES: This facility is used to conduct exploratory and advanced development in air-breathing propulsion, rockets, and aerodynamic tests at sea level conditions. The cell has a control and data recording panel located just outside the cell wall. The data acquisition system is a photo-panel on which the various gages are mounted and photographed from the rear while the test conductor watches them through a two-way mirror.

Engine components and auxiliary systems testing is possible for afterburners, combustors, compressors, exhaust nozzles, heat exchangers, inlets, and ignition systems. Applicable engine types are ramjets, scramjets, and convertible scramjets.

OTHER SERVICES: Dry air is available for 103 cfm at 103 psia; Service air, 10 lb/sec at 105 psia; Portable hydraulic systems, 0 to 23 gal/min at 3015 psia and 10 gal/min at 5015 psia; Steam, 270,000 lb/hr at 415 psia at 700°F; and Service water, 650 gal/min at 75 psia.

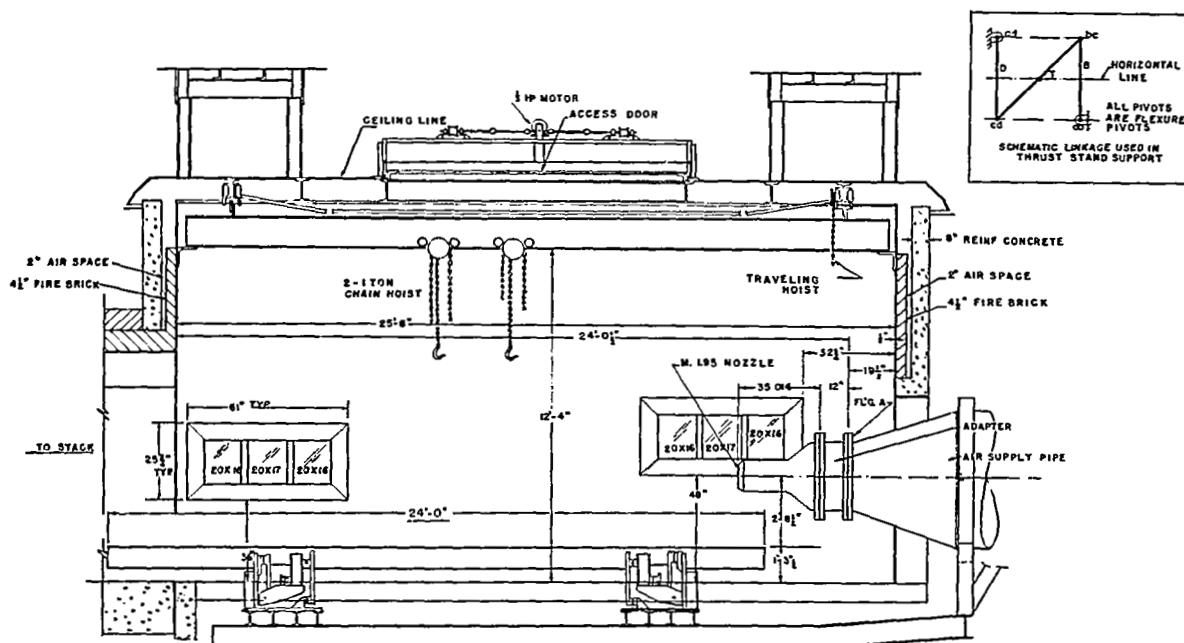
NOTE: Sea Level Test Cells 1 and 2 were constructed as a unit having a common air, fuel and water supply all in one building. Construction costs are shown on this unit basis.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$3360	CONSTRUCTION YEAR: 1946 COST \$ 498,243 ESTIMATED REPLACEMENT VALUE \$1,709,420
CONTRACTOR: Service Technology Corporation	LOCATION: Daingerfield, Texas
IMPROVEMENTS AND COSTS: (1959) Improvements, Cost \$763,606.	

PLANS FOR FACILITY IMPROVEMENTS: Install data transmission cable to permit use of data acquisition system of Cells 3, 4, and 6 by Cells 1 and 2.

SCHEMATIC



FACILITY PERFORMANCE DATA

PERFORMANCE PARAMETERS

Total Temperature (°R): 1060  
 Total Pressure (psia): 125  
 Mass Flow Rate (lb<sub>m</sub>/sec): 300  
 Run Time: Continuous  
 Maximum Engine Thrust  
 Measuring Capability (lb<sub>f</sub>): 60,000

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons (Portable System)	300 gallons	915	200	90

## UAC RAMJET CONNECTED PIPE TEST FACILITY

REPORTING INSTALLATION: United Aircraft Corporation United Aircraft Research Laboratories East Hartford, Connecticut	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: United Aircraft Research Laboratories
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: J. L. Preston, Supervisor, Experimental Test Facilities; Facilities Office, Willgoos Lab. Phone: (203) 565-8809

## DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** The ramjet connected pipe test facility, which is usually operated in an intermittent blowdown mode, is supplied with dry air from a 400 psi, 15,000 cu ft capacity storage system. The test air, which can be divided into two flow systems to provide primary engine airflow and secondary cooling airflow to a test engine, is heated by instream hydrogen fueled combustion type heaters. Ramjet engine models of up to 15 inches in diameter can be accommodated in this facility. The facility exhausts to atmosphere.

**TESTING CAPABILITIES:** The ramjet connected pipe test facility is used to conduct aerothermodynamics, materials, exploratory and advanced development tests in airbreathing propulsion systems. Engine dynamic simulation capability includes engine variable geometry control, engine fuel control, and free stream variation. Test data are obtained by means of a high speed automatic data acquisition system, designed to accept up to 20 channels of analog data. The sampling rate per channel is normally 10 samples per second, which is the limiting speed of the submultiplexer system. The data acquisition system does have the capability to step submultiplexers, providing for measurement of 144 pressures and 288 temperatures.

Engine components and auxiliary system testing is possible for afterburners, combustors, inlets, and variable geometry control. Applicable engine types are ramjets and scramjets.

## FACILITY COST HISTORY

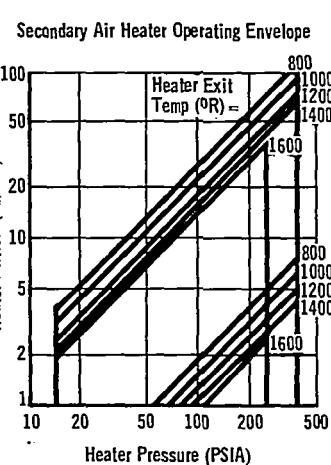
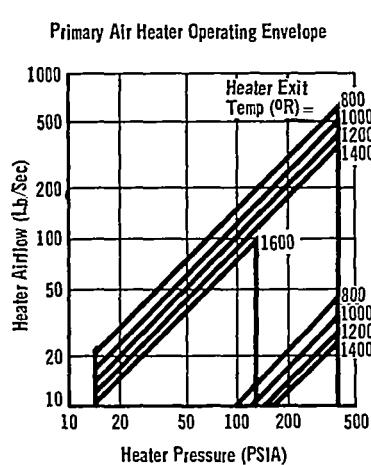
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not available	CONSTRUCTION YEAR: COST \$ Not available ESTIMATED REPLACEMENT VALUE \$ available
CONTRACTOR:	LOCATION:
IMPROVEMENTS AND COSTS: Not available.	

PLANS FOR FACILITY IMPROVEMENTS: Not available.

SCHEMATIC

(Not Available)

FACILITY PERFORMANCE DATA



PERFORMANCE PARAMETERS

HEATED AIR:

Total Temperature  
vitiated air (°R): 1600  
Total Pressure (psia): 250  
Mass Flow Rate (lb<sub>m</sub>/sec): 200  
Flow Duration (sec): 35 (minimum)

DRY PRESSURIZED AIR (2 compressors)

Total Temperature (°R): Ambient  
Total Pressure (psia): 400  
Mass Flow Rate (lb<sub>m</sub>/sec): 10  
Flow Duration: Continuous

DRY PRESSURIZED AIR (2 compressors plus  
3 storage tanks)

Total Temperature (°R): Ambient  
Total Pressure (psia): 250  
Mass Flow Rate (lb<sub>m</sub>/sec): 200  
Flow Duration (sec): 35 (minimum)

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia) (Storage)	Delivery (lb <sub>m</sub> /hr) (Delivery)	Temperature Range (°F)
Hydrocarbons (JP 5)	18,000 gallons	Ambient 1500	15,350	50 to 110
Hydrocarbons (JP7, Shell dyne)	275 gallons	Ambient 1000	1,080	Ambient to 1000
Gaseous Hydrogen	350,000 SCF	2200 1000	2,700	Ambient
Alcohol	4,000	Ambient 1000	2,000	Ambient

UAC SEA LEVEL JET TEST STAND NO. A-1  
(Florida Research and Development Center)

REPORTING INSTALLATION: United Aircraft Corporation Pratt and Whitney Aircraft Division 400 Main Street East Hartford, Connecticut 06108	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Experimental Test Department East Hartford, Connecticut
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: J. L. Preston, Supervisor, Experimental Test Facilities; Facilities Office, Willgoos Laboratory Phone: (203) 565-8809

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This facility (located at West Palm Beach, Florida) is an outdoor sea level direct connect test stand with altitude capability. The test section diameter is 6 feet. A jet engine is used together with plenum and demineralized water injection through a suitable system of valves and ductwork to supply heated air to the test engine, thus simulating high Mach number, high altitude testing. The engine is shrouded to simulate high temperature air and exhaust through an ejector to improve pressure recovery.

**ALTERNATE FACILITIES:** Three alternate and similar test stands are available. Cell No. A-2 is identical to Cell No. A-1 whereas the other two do not provide heated inlet air or altitude capability. Additional smaller test stands are also available.

**TESTING CAPABILITIES:** This facility is used to provide heated inlet conditions for endurance testing. Applicable engine types are turbojets (dry and w/afterburner), turbofans (dry and w/afterburner) and turbofans (w/duct burning). A heated fuel system capable of simulating a complete mission cycle is available. A steady state data system tied to an on-line computer is used to provide data recording and computation for 250 channels of pressure data and 175 channels of temperature data. A transient data system with 40 data channels is also available. Control instrumentation includes 35 data channels and 8 for continuous monitoring.

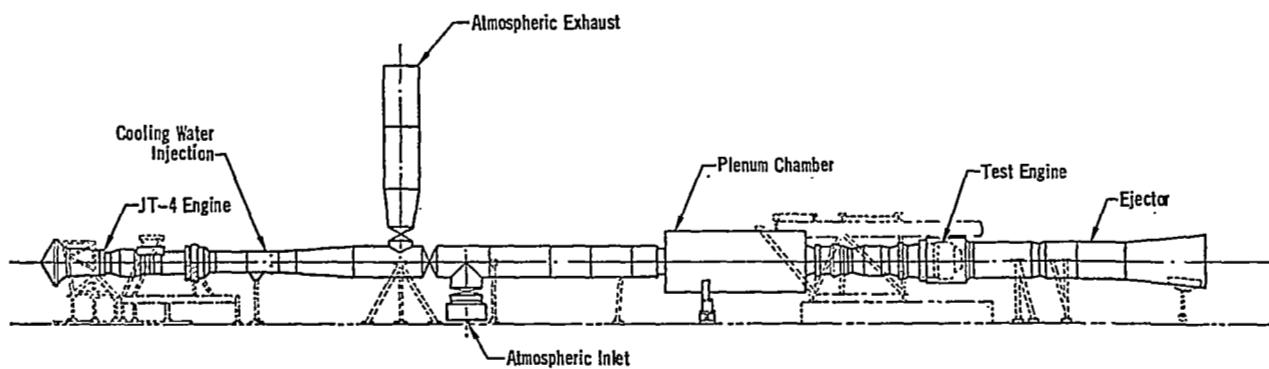
**OTHER SERVICES:** Auxiliary air is provided for 15 lb/sec at 105 psia at 400°F; Service air, 350 lb/min at 65 psia; and Demineralized water (5000 gal reserve), 100 gal/min at 100 psia.

FACILITY COST HISTORY

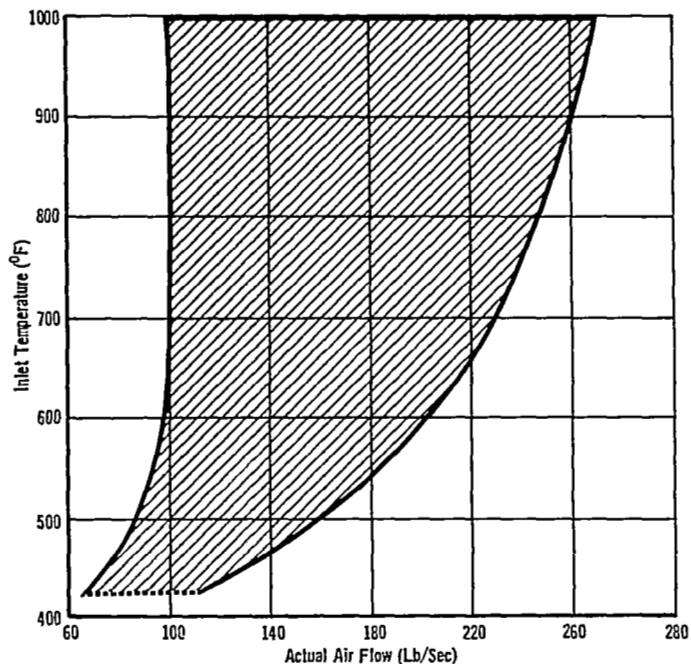
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not available	CONSTRUCTION YEAR: ESTIMATED REPLACEMENT VALUE \$	COST \$ Not available
CONTRACTOR:	LOCATION:	
IMPROVEMENTS AND COSTS: Not available		

PLANS FOR FACILITY IMPROVEMENTS: Not available.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range with true  
 temperature simulation °R: 3.2  
 Total Temperature (°R)  
 (Vitiated Air): 1460  
 Total Pressure (psia): 30  
 Mass Flow Rate (lb<sub>m</sub>/sec): 265  
 Maximum Run Time: Continuous  
 Maximum Altitude (feet): 72,000  
 Maximum Engine Thrust  
 Measuring Capability (lbf): 60,000

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons Natural gas	2.3K gallons Not Applicable	Ambient 400	840,000 15,000	Ambient to 300 Ambient



4. PROPULSION WIND TUNNELS

AEDC PROPULSION WIND TUNNEL FACILITIES

REPORTING INSTALLATION: Arnold Engineering Development Center (AEDC) Arnold Air Force Station, Tennessee 37389	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Air Force Systems Command
OTHER SOURCES OF INFORMATION: Test Facilities Handbook, AEDC 8th Edition, December 1969	LOCAL OFFICE TO CONTACT FOR INFORMATION: Director of Test (AET) Phone: (615) 455-2611, ext 625 or 645

INFORMATION ON THE FOLLOWING FACILITIES:

Propulsion Wind Tunnels (PWT-16S & 16T)

IS SUBJECT TO SPECIAL EXPORT CONTROLS. FURTHER INFORMATION MAY BE OBTAINED FROM:

Air Force Systems Command  
Arnold Engineering Development Center  
Arnold Air Force Station, Tennessee 37389




GENERAL APPLIED SCIENCE LABORATORY  
HIGH TEMPERATURE COMBUSTION TUNNEL

REPORTING INSTALLATION General Applied Science Laboratory Merrick & Stewart Avenues Westbury, Long Island, New York 11590	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Applied Aerodynamics Division
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Same as Above Phone: (516) 333-6960

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel operates as a blowdown facility from a 2000 psi air storage farm of over 1000 ft<sup>3</sup>. A set of nozzles with Mach numbers from 2.7 to 7.5 of various contours and test section size as listed below are compatible with the combustor shown on the opposite page.

Nozzle Type	Mach No.	Nozzle Size (inches)	Nozzle Type	Mach No.	Nozzle Size (inches)
2D Retangular	2.7	8 X 10	3D Rectangular	5	9 X 12
2D Rectangular	3.1	5 X 6	3D Square	5.5	14.5 X 14.5
2D Rectangular	4	8.5 X 10.5	3D Conical	6	12.25 diam
3D Conical	4	7.5 Dia	3D Conical	.7	12.25 diam
2D Rectangular	5	5 X 6	3D Conical	7.5	12.25 diam

The combustors can be used to supply other than supersonic or hypersonic environments. By direct hook-up, engine burners or nozzles can be tested with the discharge conditions listed as follows: Maximum flow rate: 50 lb/sec; Maximum pressure: 1500 psi; and Maximum temperature: 4500°R.

TESTING CAPABILITIES: Experiments can be performed in any of the listed nozzles with discharge through fixed area diffusers to atmosphere or to a 40,000 cu ft vacuum sphere. Force, and heat transfer measurements and pressure transducer outputs can be recorded on 4 optical galvanometer recorders with 12 channels on each or on single and double channel brush recorders. Pressure measurements may be multiplexed through use of a set of scanivalves for various pressure levels. A shadowgraph is available for flow visualization. Components testing (with applicable engine types shown in parentheses) are possible for afterburners and combustors (ramjets, scramjets, and convertible scramjets), exhaust nozzles (turbojets and turbofans, both dry, turboramjets, ramjets, scramjets, and convertible scramjets), and inlets (turbojets, dry, ramjets, scramjets, and convertible scramjets).

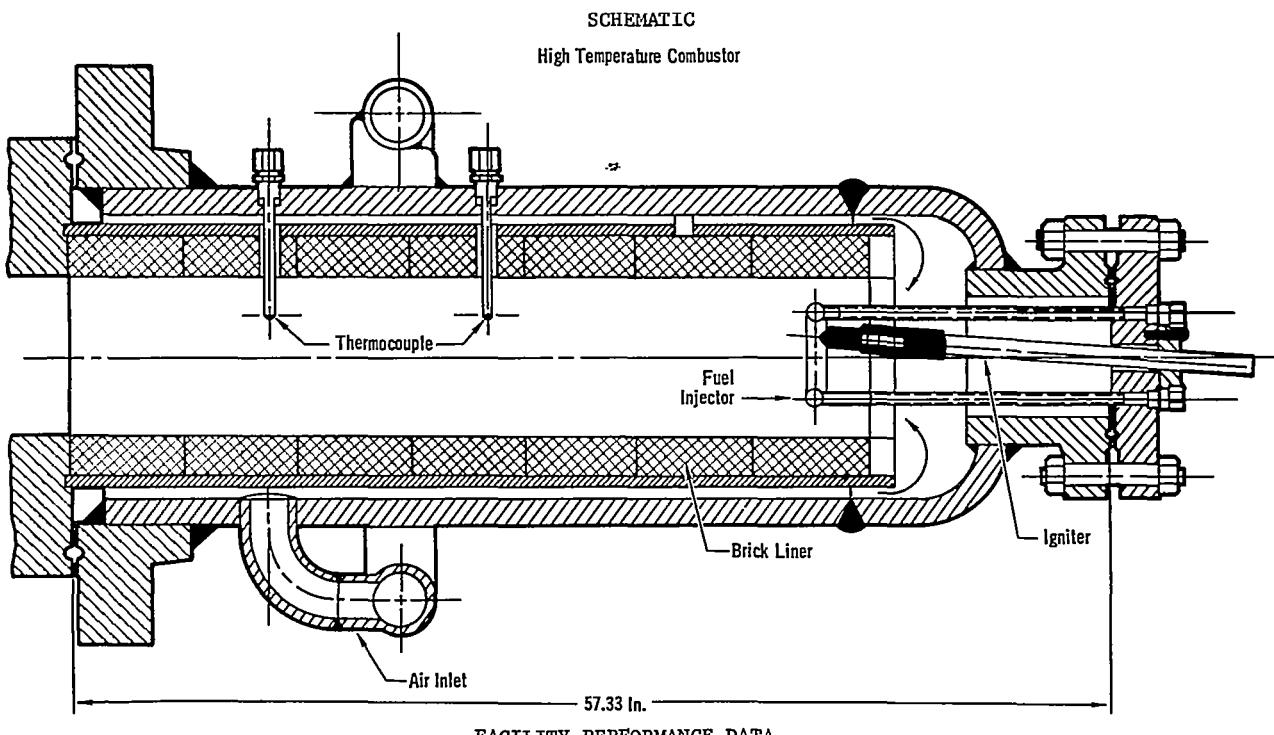
OTHER SERVICES: An auxiliary supply is available in unlimited quantity at 100 psi; Dry Air, 1000 ft<sup>3</sup> at 2000 psi and 2500 ft<sup>3</sup> at 6000 psi; and service air, unlimited quantity at 100 psi.

Notes Below: \*Depends on personnel, supporting equipment and instrument requirements.  
\*\*Combustor alone, costs are not separable from total test complex.

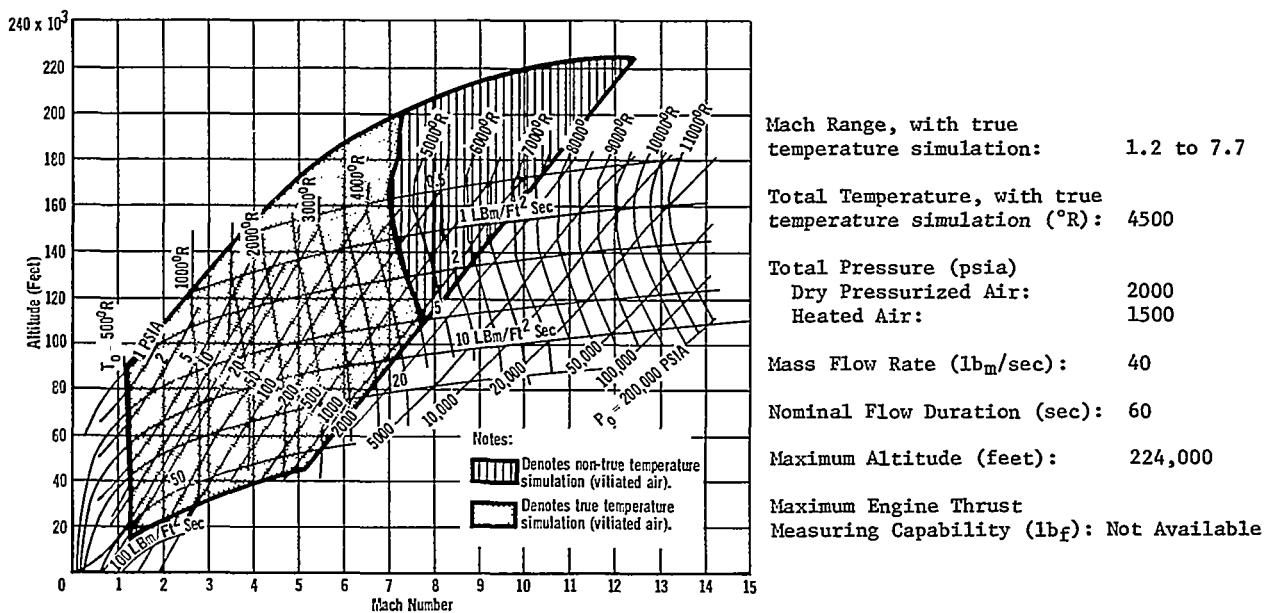
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$1000*	CONSTRUCTION YEAR: 1963 COST \$ Not Available ESTIMATED REPLACEMENT VALUE \$25,000**
CONTRACTOR: General Applied Science Laboratory IMPROVEMENTS AND COSTS:	LOCATION: Westbury, New York

PLANS FOR FACILITY IMPROVEMENTS: None



FACILITY PERFORMANCE DATA



ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range ( $^{\circ}$ F)
Hydrocarbons Gaseous Hydrogen	10 gallons 30 ft <sup>3</sup>	515 2215	7000 200	0-500 0-1000

GENERAL APPLIED SCIENCE LABORATORY  
PEBBLE-BED HEATED AIR BLOWDOWN WIND TUNNEL

REPORTING INSTALLATION: General Applied Science Laboratories Merrick & Stewart Avenues Westbury, Long Island, New York 11590	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Applied Aerodynamics Division
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Same as Above Phone: (516) 333-6960

DESCRIPTION AND TESTING CAPABILITIES

**FACILITY DESCRIPTION:** This wind tunnel is supplied from the 2000 psi tank farm which drives air through a ceramic pebble bed heat exchanger into a range of wind tunnel nozzles as listed below. At pressures up to 1500 psi and mass flows to 14 lbs/sec, clean air can be furnished at temperatures up to 2500°R for periods in excess of 30 seconds (time increased with reduced flow). Maximum delay between tests is 4 hours. With the addition of a booster afterburner, vitiated air can be delivered at up to 5500°R, but running times are shortened by material considerations.

Nozzle Type	Mach No.	Nozzle Size (inches)	Nozzle Type	Mach No.	Nozzle Size (inches)
3D Conical	4	12.25 Dia	3D Conical	7.5	12.25 Dia
3D Conical	5.5	12.25 Dia	3D Axisym	6	12 Dia
3D Conical	6	12.25 Dia	3D Square	12	27.5 X 27.5
3D Conical	7	12.25 Dia			

**TESTING CAPABILITIES:** Discharge can be made to the atmosphere or into the vacuum sphere. Measurements of pressure and temperature are transcribed on oscillograph recorders with 48 channels of information. A range of multiplexing scanivalves is also available. Shadowgraph and Schlieren apparatus are available for flow visualization.

Engine component testing is possible for afterburners and combustors of ramjets, scramjets, and convertible scramjets, for exhaust nozzles of turbojets and turbofans (both dry), turboramjets, ramjets, scramjets, and convertible scramjets, and inlets of turbojets, (dry) ramjets, scramjets, and convertible scramjets.

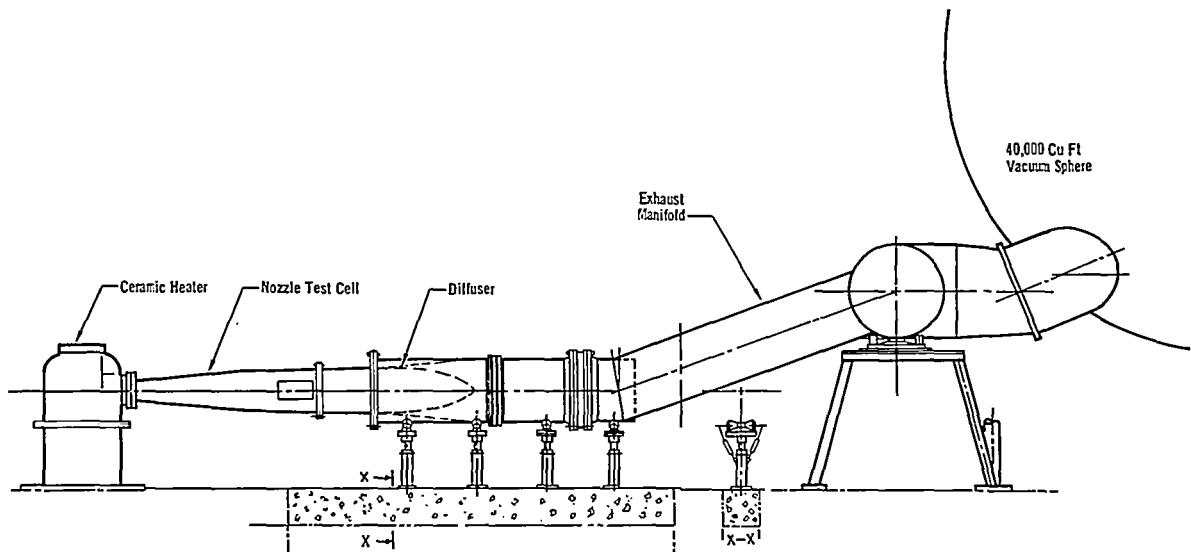
**OTHER SERVICES:** Auxiliary air is available in unlimited quantity at 100 psi; Dry air, 1000 ft<sup>3</sup> at 2000 psi and 2500 ft<sup>3</sup> at 6000 psi; and Service air, unlimited quantity at 100 psi.

\*Note Below: Dependent on personnel and supporting equipment.

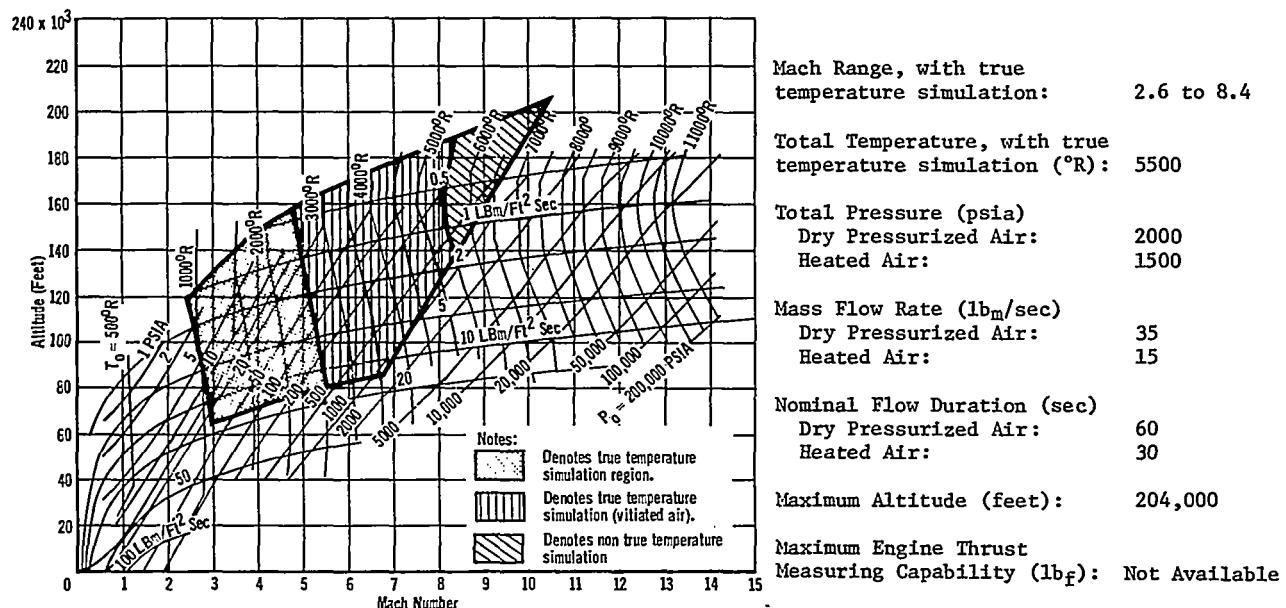
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$1000*	CONSTRUCTION YEAR: 1962 COST \$25,000 ESTIMATED REPLACEMENT VALUE \$75,000
CONTRACTOR: General Applied Science Laboratories	LOCATION: Westbury, New York
IMPROVEMENTS AND COSTS: Component improvements not separate from total facility.	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery ( $\text{lb}_m/\text{hr}$ )	Temperature Range ( $^{\circ}\text{F}$ )
Hydrocarbons Gaseous Hydrogen	10 gallons $30 \text{ ft}^3$	515 2215	7000 200	0-500 0-1000

NASA LEWIS HYPERSONIC TUNNEL FACILITY  
(Plumbrook Station; Sandusky, Ohio)

REPORTING INSTALLATION: NASA Lewis Research Center 21000 Brookpart Road Cleveland, Ohio 44135	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Physics and Chemistry Division
OTHER SOURCES OF INFORMATION: NASA, "Technical Facilities Catalog", Vol. I, NHB 8800.5, March 1967.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Physics and Chemistry Division Org Code: 2100 Phone: (216) 433-4000, ext 432

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a high temperature blowdown facility utilizing an inductively heated drilled core graphite storage heater for the heat source. Free jet nozzles (3.5 foot exit diameter) are used to produce nominal Mach numbers of 5, 6, and 7 in the test section. The inviscid test core is nominally 3 feet in diameter. The facility can also be used in the direct connect mode. The heat reservoir consists of a 30 ft stack made up of 15 graphite cylinder sections nominally 6 ft in diam. and 2 feet high. Each cylinder is drilled with 3/4 inch holes on a pitch diameter of 1 1/2 inches. Thermal insulation is provided by 7 inches of carbon felt. The graphite cylinders are inductively heated and a gaseous mixture of O<sub>2</sub> and N<sub>2</sub> is convectively heated prior to flowing into the test section. An O<sub>2</sub> - N<sub>2</sub> mixture is used at Mach numbers of 5 and 6 while O<sub>2</sub> is used for the Mach 7 condition. Induction heating equipment includes four individually controlled induction coils, each powered by a 750 kW, 180 cycle, single phase, 750 volt power supply. Altitude exhaust conditions are provided by a steam jet ejector. A 700,000 SCF, 5000 psi railroad tank car is used to provide nitrogen storage while a tank farm of 6 storage bottles is used for oxygen storage.

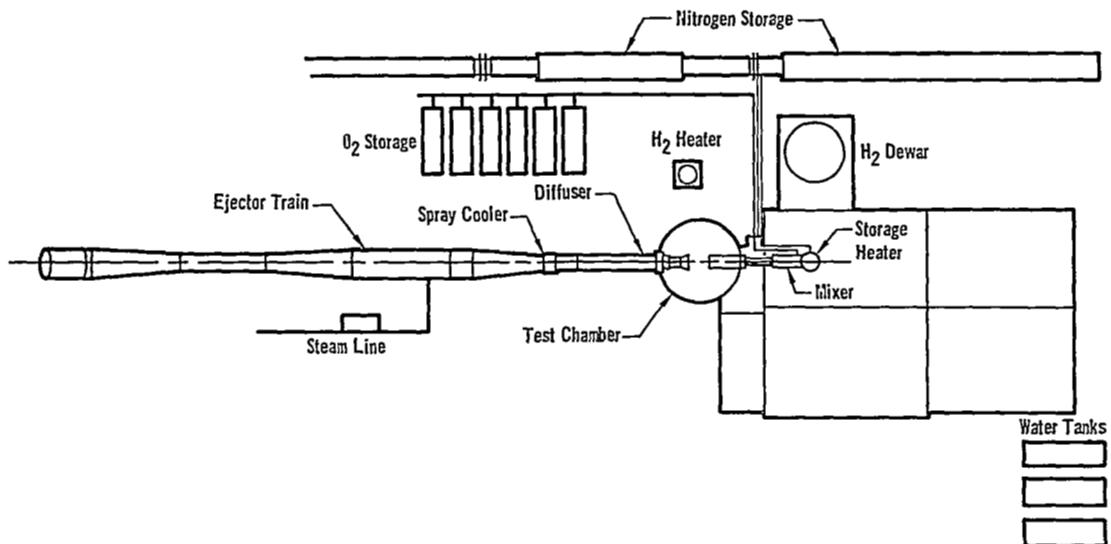
TESTING CAPABILITIES: This facility can be used to test research scale ramjet engines. Aerodynamic tests can be conducted with or without true temperature simulation.

FACILITY COST HISTORY

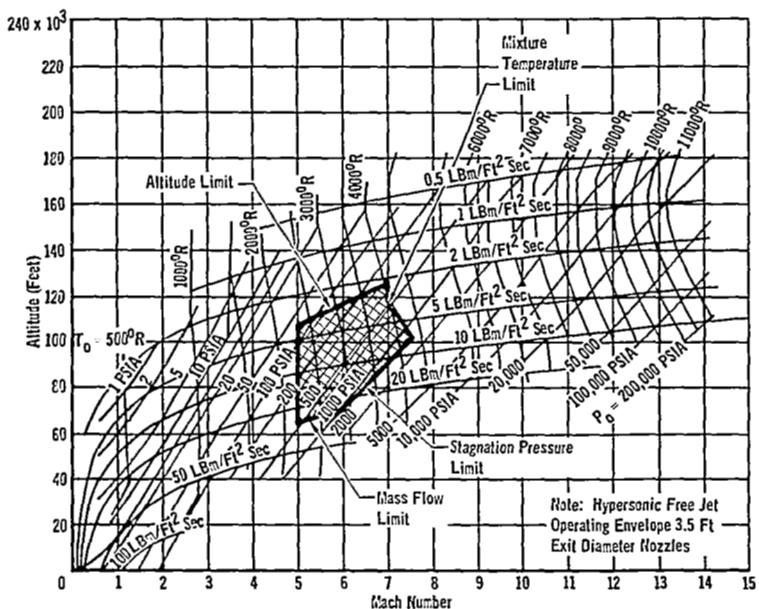
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1966-67 COST \$2.4K (est) ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR:	LOCATION:
IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: Not Available

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range, with true temperature simulation: 5, 6, & 7  
 Total Temperature, with true temperature simulation (°R): 4100  
 Total Temperature, vitiated air (°R): 4800 direct connect mode  
 Total Pressure (psia): 1200  
 Mass Flow Rate (lb/sec): To 220  
 Maximum Altitude (feet): 130,000 @ M = 7  
 Nominal Flow Duration (sec): 120 to 180  
 Maximum Engine Thrust  
 Measuring Capability (lb<sub>f</sub>): 10,000 (free jet (20,000 (direct connect))

ENGINE FUEL SUPPLY CAPABILITY

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Liquid Hydrogen			10,800	
Gaseous Hydrogen			12,600	1200

NASA LEWIS 10- BY 10-FOOT SUPERSONIC WIND TUNNEL

REPORTING INSTALLATION: NASA Lewis Research Center 21000 Brookpark Road Cleveland, Ohio 44135	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Advanced Systems Division
OTHER SOURCES OF INFORMATION: NASA, "10- By 10-Foot Supersonic Wind Tunnel", Lewis Research Center, June 1959.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Advanced Systems Division Org Code: 9600 Phone: (216) 433-4000, ext 421

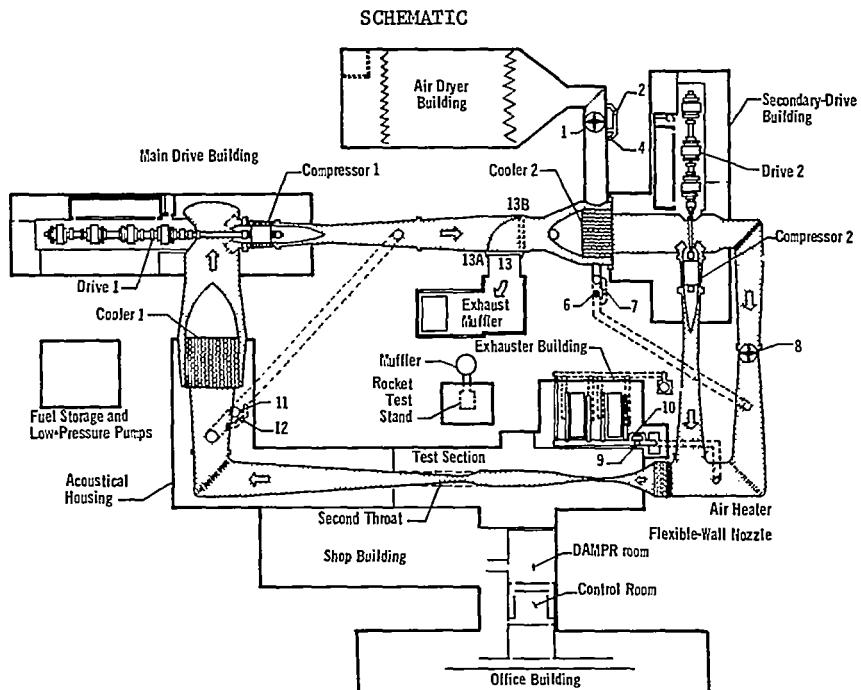
DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility has a Mach number range of 2 to 3.5. It can be operated throughout the entire Mach number range on either an aerodynamic cycle (at various air densities) or on a propulsion cycle. On the aerodynamic cycle, the tunnel operates as a closed return-type tunnel, and on the propulsion cycle, it operates as an open non-return type tunnel. A flexible plate nozzle is used to provide Mach number control into the test section which is 10 by 10 feet in cross-section by 40 feet in length. Air entering the first and second compressors is cooled by two finned-tube, water-coil type heat exchangers. The air is dried by an activated alumina drier. An exhaust muffler is used to quiet the discharge air when the tunnel is operated as an open (propulsion) circuit.

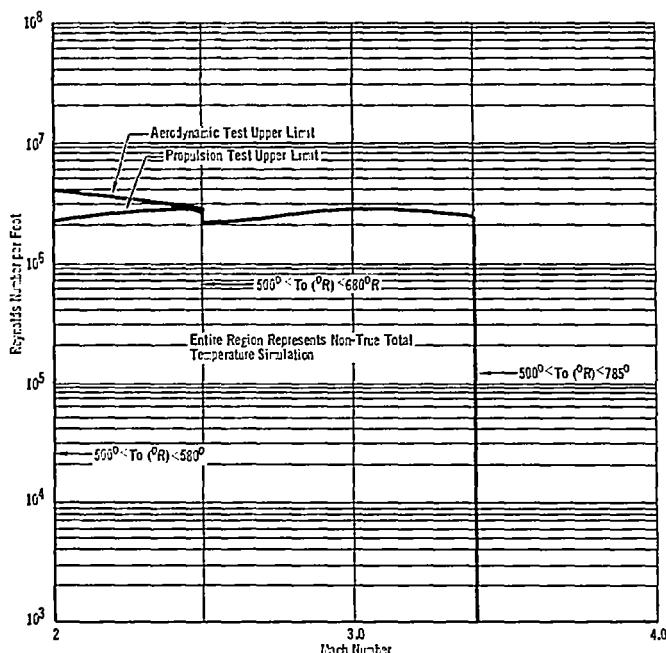
TESTING CAPABILITIES: The whole floor of the test section is capable of being lowered to the first floor level by means of four long screw jacks located at the corners of the floor. The tunnel is used for force and moment, pressure, heat transfer, flutter, internal duct flow, jet effects (hot or cold), rockets, and live engine tests. The tunnel is equipped with a sting, a strut, and a suspended model auxiliary strut for rakes used in conjunction with a suspended model. Two Schlieren systems and a TV monitoring system are available for flow visualization. The data acquisition system is part of the Central Automatic Digital Data Encoder (CADDE) which is used by many of the laboratory's major test facilities to record digital readings from transducers of pressure, voltage, events per unit time, and mechanical position. Data from the CADDE equipment is processed by an ERA 1103 (Engineering Research Associates) general-purpose computer.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	CONSTRUCTION YEAR: ESTIMATED REPLACEMENT VALUE \$ LOCATION:	COST \$ Not Available
PLANS FOR FACILITY IMPROVEMENTS: Not Available		



**FACILITY PERFORMANCE DATA**



Mach Range:	2 to 3.5
Reynolds Number ( $\times 10^6/\text{ft}$ )	
(Aerodynamic Tests):	3.35
(Propulsion Tests):	2.68
Total Pressure (psfa):	
(Aerodynamic Tests):	0 to 5000
(Propulsion Tests):	1400 to 5000
Dynamic Pressure (psfa)	
(Aerodynamic Tests):	730
(Propulsion Tests):	600
Total Temperature (°R):	500 to 785
Run Time:	Continuous
Maximum Engine Thrust Measuring Capability (lb <sub>f</sub> ):	Not Available

**ENGINE FUEL SUPPLY CAPABILITY**

Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range (°F)
Hydrocarbons Gaseous		515 315	35,300 95,800 SCFM	

NASA LEWIS 8- BY 6-FOOT SUPERSONIC WIND TUNNEL

REPORTING INSTALLATION: NASA Lewis Research Center 21000 Brookpark Road Cleveland, Ohio 44135	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Advanced Systems Division
OTHER SOURCES OF INFORMATION: NASA, "8- By 6-Foot Supersonic Wind Tunnel", Lewis Research Center, February 1959.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Advanced Systems Division Org Code: 9600 Phone: (216) 433-4000, ext 421

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is a continuous operation return or nonreturn wind tunnel with a controlled Mach number range of from 2.1 to a lower limit determined by model blocking and shock reflection. The flexible wall nozzle can be varied while the tunnel is operating to control test section Mach number. The tunnel can be operated on either an aerodynamic cycle (closed circuit) or propulsion cycle (open circuit). In the propulsion cycle, the air enters an alumina air dryer which is capable of absorbing approximately 1 ton of water per minute. The air then enters a plenum chamber and the seven-stage axial flow compressor. The test section is 8 by 6 feet in cross section by 39 feet in length. The first half of the test section is the supersonic portion, and the last half is the transonic perforated section. In the propulsion cycle, the air is then exhausted to atmosphere. The aerodynamic or closed circuit mode is similar to the propulsion cycle, except that the air is cooled by a cooler located in the duct and returned to the dryer for recirculation.

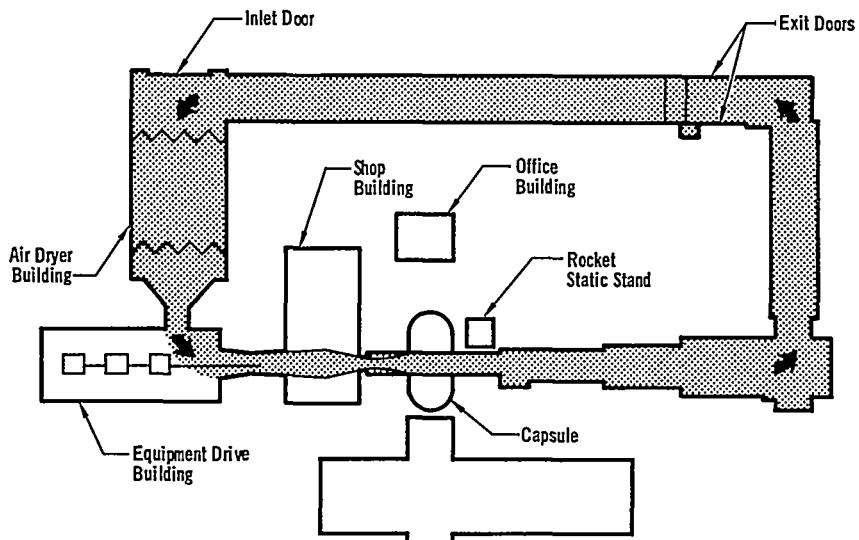
TESTING CAPABILITIES: This tunnel can accommodate force and moment, pressure, heat transfer, flutter, internal duct flow, jet effects (hot or cold), rockets and live engine tests. There are several model supports available: ceiling strut mounts, a supersonic sting mount, a transonic sting, and supersonic and transonic jet exit wing mounts. However, users may furnish their own support systems. Supersonic and transonic Schlieren systems are available for flow visualization. The data acquisition system is built around the Central Automatic Digital Data Encoder (CADDE) which is used by many of the major facilities at the Lewis Research Center to record digital readings from transducers of pressure, voltage, events per unit time, and mechanical position. After recording, the data are processed on a stored program, high-speed, general-purpose digital computer (i.e., a Sperry-Rand type 1103 Scientific Univac).

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: COST \$ Not Available ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR:	LOCATION:
IMPROVEMENTS AND COSTS: Not Available	

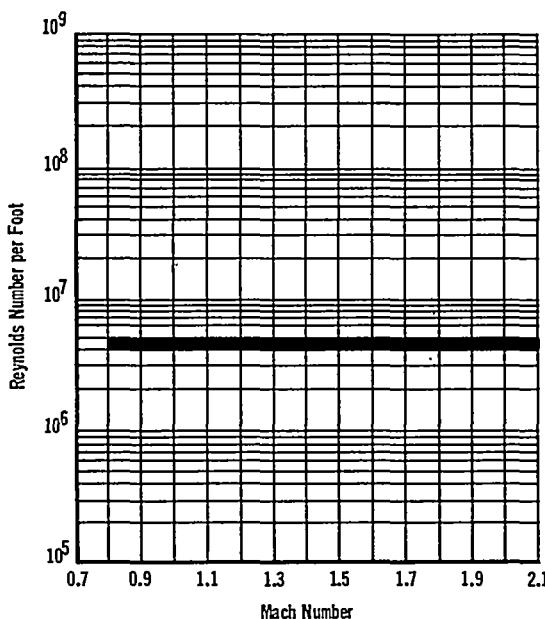
PLANS FOR FACILITY IMPROVEMENTS: Not Available

SCHEMATIC



Note: Inlet and exit doors are closed for the aerodynamic cycle, and open for the propulsion cycles.

FACILITY PERFORMANCE DATA



Mach Range: .8 to 2.1  
 Reynolds Number ( $\times 10^6/\text{ft}$ ): 4.2 to 4.8  
 Total Pressure (psfa): 2116 to 3650  
 Dynamic Pressure (psfa): 650 to 1240  
 Total Temperature ( $^{\circ}\text{R}$ ): 600 to 700  
 Run Time: Continuous  
 Maximum Engine Thrust  
 Measuring Capability (lb<sub>f</sub>): Not Available

ENGINE FUEL SUPPLY CAPABILITY				
Fuel Type	Storage Capacity	Storage Pressure (psia)	Delivery (lb <sub>m</sub> /hr)	Temperature Range ( $^{\circ}\text{F}$ )
Not Available				

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